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THE GIANT AXONS OF ANNELIDS

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THE very large nerve cells and fibres which occur in many species of annelids have always aroused considerable interest and have been the subject of numerous studies. When considered chronologically these studies show not only a gradual accumulation of information concerning giant neurones but reflect, as well, the impact of biological theories and interests in vogue at different times, and record the stimulus given to research by the discovery of new biological techniques. Throughout the nineteenth century and in the early part of the present century the intense interest in systematics led to the cataloguing and description of the Annelida. As a result of this activity there appeared the systematic and anatomical accounts of Claparède, Beddard, Meyer, Vejdovský, McIntosh, and others. As parts of larger studies these authors described the grosser features of the nervous system, recorded the presence or absence of giant fibres, and gave some particulars of their structure. More detailed knowledge awaited the introduction of greater refinements in microscopic methods—better fixatives, paraffin sections, and a greater range of selective stains. With such means, more exact studies of the annelid nervous system were rendered possible, for example, those of Friedländer, Rohde, Spengel, Retzius, and Ashworth. Towards the end of the last century a fresh impetus was given to research by the discovery of special neurological stains, methods of silver impregnation and staining with intra vitam methylene blue, which were soon used on the annelid nervous system. These histological studies of the nervous system and the giant axons of the Annelida have continued sporadically to the present day and, in addition, have been reinforced by physiological investigations during the past few decades.

HISTORICAL

Giant nerve fibres were first described in the lobster and the crayfish by Ehrenberg in 1836, and investigations on giant axons were confined to the Crustacea for the next 25 years. Claparède (1861) revealed the existence of giant nerve fibres in the Annelida when he described an axial canal in the nerve cord of two oligochaetes, *Lumbricillus* (= *Pachydrilus*) and *Clitellio*. In a later paper (1862) he described axial canals in the nerve cords of various aquatic oligochaetes, each fibre consisting of a relatively less refringent substance than the surrounding thick sheath. Giant axons in polychaetes were observed for the first time by Keferstein (1863) in the nerve cord of *Notomastus latericeus* Sars (= *Capitella rubicunda* Keferstein). Subsequently, giant axons were recorded in numerous other oligochaetes and polychaetes, and descriptions, largely fragmentary, are available now for several hundred species of chaetopods.

The giant nerve fibres of annelids are so conspicuous, and they resemble so little the conventional picture of a vertebrate nerve fibre, that for a long time their nature was in doubt, and many

zoologists refused to believe that they could be nervous structures. Consequently, some investigators felt free to exercise their imagination in postulating function from structural appearance. The resultant crop of theories included the most diverse possibilities. Summaries of some of this literature have been given by Eisig (1887), Friedländer (1889, 1894), Lewis (1898), Ashworth (1909), and Stough (1926) under convenient subject headings like the following: giant fibres regarded as (1) true nerve fibres; (2) degenerate nerve fibres; (3) non-nervous elements, on account of their staining reactions; (4) supporting structures homologous with the notochord of vertebrates; (5) supporting structures not homologous with the notochord of vertebrates; (6) canals with no definitely stated function; (7) nutritive tubes; (8) excretory canals.

Leydig (1864a, 1865, 1886) first advanced the hypothesis that the giant fibres of the earthworm are true nerve fibres. He described them as giant dark-walled nerve fibres and stated that they stain like the nerve fibres of vertebrates, that their contents correspond to the axis cylinders and their walls to the myelin sheaths of an ordinary vertebrate medullated nerve, but that they lack an envelope corresponding to the sheath of Schwann. During the half century that followed the publication of Leydig's treatise on histology, a controversy arose concerning the significance of the giant axons of the Annelida. The nervous nature of the giant axons of the decapod Crustacea was accepted generally, but no such agreement prevailed concerning the giant axons of the Annelida, and there were as many advocates of non-nervous theories as there were supporters of a nervous function. It is to the latter workers that we owe the larger part of our knowledge of the histological structure of these axons. The proofs that they advanced for their hypothesis comprised the following details: presence of neurofibrillae in the axon; myelin sheaths; branching of the fibres; origin from nerve cells.

Schultze (1879) described neurofibrillae in the giant fibres of *Lumbricus* and established for the first time that the sheaths of these fibres are myelinated, blackening in osmium tetroxide. Langerhans (1880) used the same reagent on the giant fibres of the polychaete *Prionospio steenstrupi* Malmgren and obtained a darkening of the giant axon sheath. The next advance was due to Spengel (1881), who showed that in *Halla* (Lysaretidae) the giant fibres arise as processes of large nerve cells in the cord. He estimated that there are about 20 such cells and since the number of large nerve fibres remains fairly constant (about 7) in any one animal, he concluded that a fusion of processes must occur. This account has especial interest in that it introduces the concept of syncytial giant axons which since that time have been demonstrated in a number of invertebrate phyla, although it must be stated that Ashworth (1909) subsequently showed that the giant axons of *Halla* are unicellular structures and that the relatively small and constant number of giant axons in this species is due to termination of the fibres at successive levels in the nerve cord. The nerve cells of the giant axons, in general, have proved to be very elusive structures, and there is probably no species of annelid in which the arrangement of giant axon nerve cells has been determined with as rigorous proof as that used in studies of vertebrate neurology. Rohde (1887) described some of the nerve cells of the giant fibres in the Aphroditidae, Sigalionidae, and Polynoidae, and finally Friedländer, in three papers that are now classical (1888, 1889, 1894), traced the connexions between giant axons and nerve cells in *Lumbricus* and *Mastobranchus* (Capitellidae) and definitely established the fact that giant axons of these two animals are syncytial structures.

Subsequent to 1900 the nervous nature of annelid giant fibres received nearly universal acceptance, but the substantiating evidence was entirely histological and far from complete. It was only in a small number of species that the nerve cells of the giant fibres had been found; in other species the nerve cells were sought in vain. Neurofibrillae were seen in the giant fibres of some oligochaetes and of a few polychaetes, but again were by no means universal. The myelinated sheath of the giant fibre was certainly dissimilar to that of a vertebrate nerve fibre, in that it contained connective tissue and lacked a circumscribing neurilemma and nodes of Ranvier. Moreover, its presence had been established only in lumbricids and a few polychaetes. The methods used to reveal the occurrence of myelin included: oxidation by osmium tetroxide, staining with quinolein blue, solubility in alcohol, fixation by chrome salts and birefringence under crossed-Nicols. Not all of these methods are equally reliable. The reduction of osmium tetroxide is not specific for fatty material, although it does occur in the presence of unsaturated fats. It is a useful morphological aid (Dempsey and Wislocki, 1946), but since reduction

is induced by other substances also, and since the conditions for this reaction are variable and difficult to control, it is a very unreliable agent for the detection of diffuse and scanty lipoids (Baker, 1944; Lison, 1936; Owens and Bensley, 1929). Friedländer (1889) found that the sheaths of the giant axons of *Lumbricus* and *Mastobranchus* appear birefringent in polarized light, but in these animals the sheaths contain a considerable amount of lipoid that stains with osmic acid; in *Dasybranchus* (Capitellidae) he found the birefringence of the giant axons to be much weaker. The methods available to Friedländer were inadequate to make a quantitative study of axon sheath birefringence and myelination, for it is only recently that Bear and Schmitt (1937) have shown by special methods of analysis that the birefringence of invertebrate axon sheaths varies in a continuous manner from the largest to the smallest fibres. They have stated, moreover, that the ultra-structure of the sheaths of unmyelinated fibres is essentially similar to that of myelinated fibres, and they refer differences in the physical and optical properties of these two arbitrary categories of fibres to variations in the relative proportions of oriented lipoid and protein molecules present. No significance attaches to results obtained with quinolein blue. According to Gatenby and Painter (1937), this dye was employed by Ranvier for showing fatty material, but the composition of the dye used is unknown.

Friedländer (1889) believed the giant fibres to be especially long axons that conduct nerve impulses causing widespread contraction of longitudinal muscles, but his experimental proof for this hypothesis was inadequate. Bovard (1918b) attacked the problem again when he discovered that the giant nerve fibres of the earthworm regenerate more slowly than the rest of the nerve cord after transection. In correlation with this fact, he observed that there is a corresponding delay in the return of end-to-end contractions of the entire body, in contrast to the earlier return of slower peristaltic movements. Yolton (1923) and, subsequently, Stough (1930) and ten Cate (1938) made a direct approach to the problem by cutting the giant fibres of the earthworm without interrupting the rest of the nerve cord, and they found that the quick contraction proceeds only as far as the cut region. Finally, Eccles, Granit, and Young (1933), Rushton (1945a, 1946) and Bullock (1945a) have recorded action potentials of earthworm giant fibres electrically, and have proved that they are nerve axons and that their action potentials bear a definite relation to the quick contractions of the animal. More recently, Bullock (1945b, 1948) and Nicol, Smyth, and Whitteridge (1947) have made studies of the giant axons of a number of polychaetes, and have revealed further details of the functional organization of polychaete giant fibres.

Giant nerve fibres or giant axons may be defined as nerve fibres, in any species, that are disproportionately greater in size than the other nerve fibres of the animal. In absolute units they may be rather small, although having strikingly greater dimensions than other axons in the same individual. A functional distinction can be drawn as well, since in all invertebrates in which this aspect has been investigated it has been shown that they are concerned with quick escape or withdrawal movements, effected by widespread and synchronous or nearly synchronous muscular contractions (Young, 1944). It may be necessary to modify this criterion as more is learnt of the function of these structures in various groups, but the existing evidence is compatible with this viewpoint. It is in these meanings, of relatively large size and escape function when known, that the term giant axon is employed in the following discussion.

As far as possible the classification and nomenclature of the Annelida in this review conform to recent authorities. For the Polychaeta, the works of Fauvel (1923, 1927) and Hartman (1936, 1938, 1942a, 1942b, 1944, 1948) have been consulted. Since many workers have referred to *Lumbricus* or the earthworm, there is little value in presenting a detailed analysis of specific differences in the Oligochaeta, particularly the Lumbricidae, but where necessary the well-known monographs of Beddard (1895) and Stephenson (1930) have been used.

OCCURRENCE OF GIANT AXONS IN THE ANNELIDA

Giant axons have been described in various members of three annelid groups, the Archiannelida, the Polychaeta, and the Oligochaeta. These will be considered in turn.

Archiannelida

The situation in the Archiannelida is obscure, since no author who has studied the central nervous system of this group has regarded the giant fibres as nerve fibres. Perrier (1897) stated that giant nerve fibres are absent in *Polygordius* and *Protodrilus*; however, Hatschek (1878), Fraipont (1887),

and Hempelmann (1906) have described medullary canals or small spaces in the developing nerve cord of *Polygordius*. Hempelmann, in particular, followed this canal system into the oesophageal connectives and found that it terminates among the nerve cells of the supraoesophageal ganglia. It is very probable, especially from Hempelmann's description, that there is a giant fibre system, in *Polygordius* at least, among the Archiannelida. One or several giant fibres extend from the supraoesophageal ganglia throughout the length of the nerve cord. There is no information available for the cell bodies and branches of these giant axons, and their structure and arrangement need to be reinvestigated.

Polychaeta

Giant nerve fibres are of widespread occurrence in the Polychaeta, and they form a conspicuous part of the central nervous system of many species. They have been identified with certainty in the following families: Aphroditidae, Polynoidae, Sigalionidae, Nephtyidae, Nereidae, Glyceridae, Eunicidae, Lysaretidae, Lumbrineridae, Onuphidae, Orbiniidae, Spionidae, Magelonidae, Disomidae, Cirratulidae, Opheliidae, Capitellidae, Arenicolidae, Maldanidae, Sabellariidae, Ampharetidae, Terebellidae, Sabellidae, and Serpulidae. In addition, they may be present in some species of the Amphinomidae, Arabellidae, Polyodontidae, Goniadidae, and Flabelligeridae. As far as can be determined from an examination of scattered accounts, they are absent in the Phyllodocidae, Syllidae, Tomopteridae, Chaetopteridae, Scalibregmidae, and Pectinariidae. This leaves a number of families for which no information is available.

Aphroditidae. Long distance giant axons running through several segments are absent in species of this family (*Aphrodita* and *Hermione*), according to Bullock (1948), Cunningham (1887), and Rohde (1887). The latter investigator, however, found large intrasegmental nerve fibres in these animals. The fibres enter lateral nerves proceeding to the body wall and appear to arise in each segment from nerve cells lying in the lateral and ventral regions of the nerve cord.

Sigalionidae. In this family giant axons are known to occur in species of *Euthalenessa*, *Leanira*, and *Sigalion* (Cunningham, 1887; Darboux, 1899; McIntosh, 1885). Rohde (1887) has made the only detailed study of them (Figs. 1–3). Well-developed giant fibres, which extend long distances through the central nervous system, are present in *Euthalenessa* (= *Sthenelais*) *dendrolepis* Claparède and *Sigalion squamatum* Delle Chiaje. Rohde observed that the majority of giant fibres arise from giant nerve cells and are unicellular, that is, one giant fibre arises from one giant nerve cell. In *Euthalenessa*, however, there is one giant axon which arises from the fusion of the processes of two nerve cells lying in the supraoesophageal ganglia. The majority of giant fibre cells lie in the nerve cord, but in both *Euthalenessa* and *Sigalion* one of the giant fibres in the cord arises from nerve cell(s) in the supraoesophageal ganglia. It is necessary to add, however, that Rohde was not successful in discovering the nerve cell bodies of all the giant fibres which he described. Some of the giant fibres extend antero-posteriorly (*Euthalenessa*, *Sigalion*) but, in addition, postero-anterior fibres may be present (*Euthalenessa*), and the cell bodies have a corresponding location. The giant fibre sheaths are not osmiophilic. Besides fibres running a considerable distance in the central nervous system, giant cells with axons confined within the limits of one segment occur in *Euthalenessa*. The axon of each cell crosses the nerve cord to enter the body wall of the opposite side within the same segment (Figs. 5, 6).

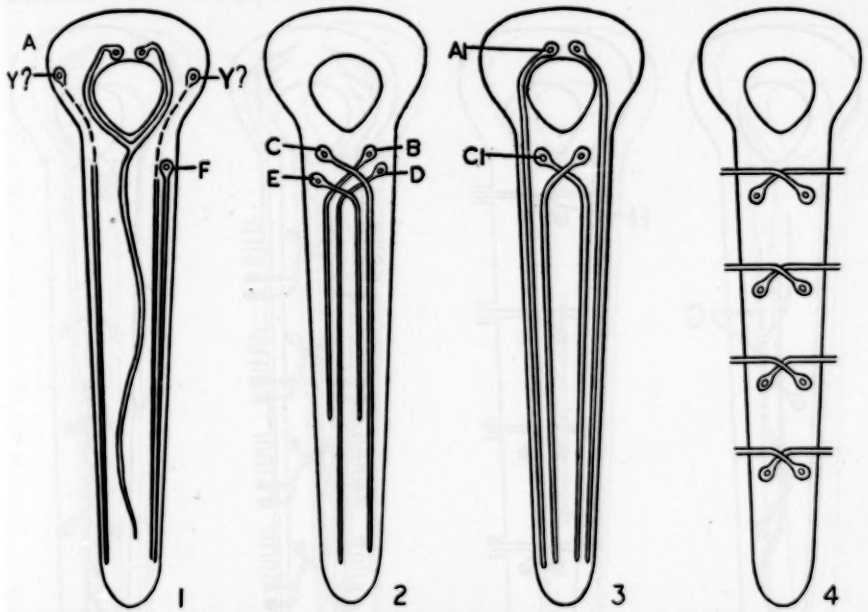
Polynoidae. Intersegmental giant axons occur in the polynoids *Harmothoë*, *Lagisca*, *Lepidametria*, and *Lepidasthenia* (Bullock, 1948; Cunningham, 1887; Michel, 1899). Rohde (1887) has dealt with the giant axons of *Lepidasthenia* (= *Polynoë*) *elegans* Grube at some length, and Haller (1889) subsequently added further details (Fig. 4). There are two pairs of giant fibres, a middle pair, and two larger lateral fibres. Both authors stated that these run antero-posteriorly but disagreed as to their cellular origin. Rohde followed the lateral fibres into the oesophageal connectives and suggested that they arise in the supraoesophageal ganglia; he associated the medial fibres with contralateral giant cells in the suboesophageal ganglia. Haller considered that the lateral fibres arise in the third segment; he also discovered segmental branches that extend towards the lateral muscles from these axons. Intrasegmental giant fibres occur in the nerve cord as well: each fibre arises from a large nerve cell, crosses the cord, and enters a peripheral nerve. *Harmothoë*, *Lepidametria*, and *Lagisca* have a pair of intersegmental giant axons.

Nephtyidae. A number of authors have described

giant nerve fibres in the neuropil of the nerve cord of several species of *Nephtys* (Cunningham, 1887; Ehlers, 1868; Emery, 1886; McIntosh, 1885; Michel, 1898, 1899; Pruvot, 1885; Retzius, 1891; Saint Joseph, 1894; Schack, 1886; Spengel, 1881); but no author has directed his attention to making a detailed anatomical study of these strutcures. Although there is a considerable amount of variation in the descriptions, they indicate that there are four large fibres and several smaller ones extending long distances in the nerve cord. Bullock (1948) also has recorded spike potentials from *Nephtys* corresponding to four main fibres.

Ichthyotomidae. Eisig (1906) described two types of giant fibres in the nerve cord of the parasitic species *Ichthyotomus sanguinarius* Eisig. Nerve fibres of the first type extend considerable distances in the nerve cord; the nerve cell bodies of these fibres are unknown. Fibres of the second type arise from giant nerve cells in each segment and enter the peripheral nerves of the same metamere.

Glyceridae. Several species of *Glycera* and *Hemipodus* (?) contain relatively small giant axons. There are two dorso-medial giant fibres in the nerve cord of most species and several other similar and smaller fibres (Ehlers, 1868; Eisig, 1887; McIntosh, 1877, 1885, 1923; Michel, 1899; Saint Joseph, 1894). In *Glycera dibranchiata*, Bullock (1948) found four pairs of large fibres and one to three pairs of small variable fibres. Corresponding to this arrangement, up to eight separate spike potentials were recognized. Gravier (1898) suggested that the giant axons arise from very large nerve cells which occur in the supraoesophageal ganglia. In the nerve cord of *Glycera convoluta* Keferstein, the giant axons are recognizably much larger than the other axons of the cord, a median pair having an average diameter of 29μ, and several smaller fibres in the dorsal neuropil having an average diameter of 22μ. Processes of the giant cells in the supraoesophageal ganglia appear to enter the oesophageal connectives but they are

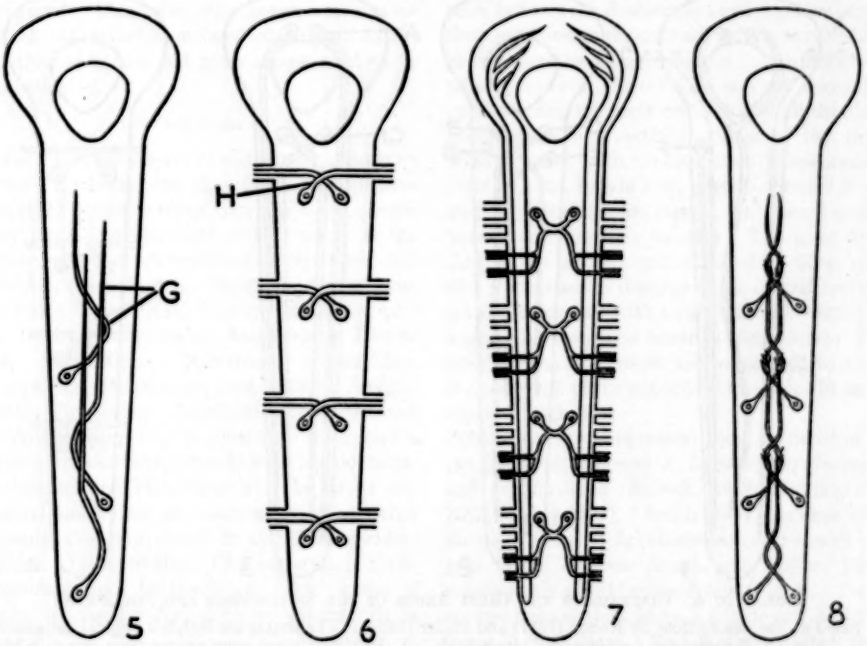


FIGS. 1 TO 4. DIAGRAMS OF THE GIANT AXONS OF THE SIGALIONIDAE AND POLYNOIDAE

Based on the descriptions by Rohde (1887) and Haller (1889). The letters are Rohde's original designations. Figs. 1 and 2. *Euthalenessa* (=*Sthenelais*) *dendrolepis*. A, Bicellular giant axon arising from two cells in the supraoesophageal ganglia. B, C D, E, F, unicellular giant axons arising from nerve cells in the suboesophageal region. Y, possible cell body of another intersegmental giant axon. Fig. 3. *Sigalion squamatum*. Al, Cl, unicellular giant axons arising in the supraoesophageal ganglia and in the anterior nerve cord, respectively. Fig. 4. *Lepidasthenia* (=*Polynoë*) *elegans*. Intrasegmental decussating giant axons proceeding to the body wall.

indistinguishable from the other nerve fibres of the connectives and have not been traced to the suboesophageal ganglia (Nicol, 1947). The giant axons of this family require further investigations to clarify their anatomical and functional arrangement.

Nereidae. Several giant axons occur in all species of *Nereis* which have been examined, and in *Perinereis* (= *Nereis*) *cultrifera* Grube (Cunningham, 1887; Dehorne, 1935; Ehlers, 1868; McIntosh, anastomosing fibres in each segment; these latter arise from a pair of nerve cells, and a fibre extends from the point of fusion to enter a peripheral nerve on either side of the nerve cord. In addition, there is a third pair of smaller median fibres which extend anteriorly through two segments only. These fibres are unicellular, decussate with each other several times, but remain anatomically distinct. Retzius (1891) observed neurones in the nerve cord similar to the decussating and anastomosing



FIGS. 5 TO 8. DIAGRAMS OF THE GIANT AXONS OF SIGALIONIDS (5, 6) AND OF NEREIDS (7, 8)

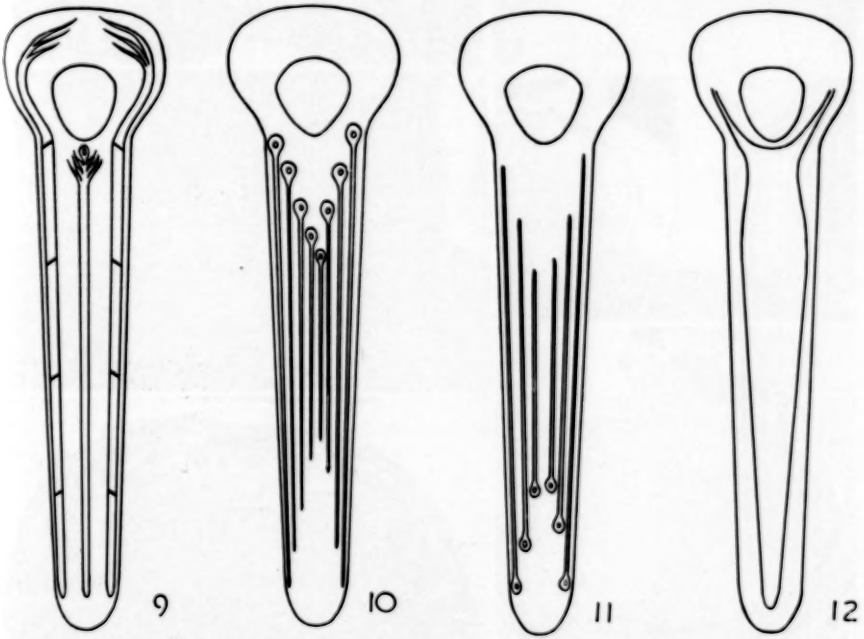
Figs. 5 and 6. *Euthalenessa dendrolepis.* G, postero-anterior intersegmental giant fibres. H, intrasegmental giant axons (based on Rohde, 1887). Figs. 7 and 8. *Neanthes virens.* Description in text (based on Hamaker, 1898).

1877, 1885, 1923; Michel, 1898; Nansen, 1887a, 1887b; Schröder, 1886). Hamaker (1898) has given a detailed account of these structures in *Neanthes* (= *Nereis*) *virens* Sars (Figs. 7, 8, 9, 13). A pair of large lateral fibres and a single smaller median fibre extend throughout the nerve cord. The median fibre is connected with one or more cells in the suboesophageal ganglion; the lateral fibres pass into the oesophageal connectives and possibly extend into the supraoesophageal ganglia. The lateral fibres are in contact with a pair of fibres described by Hamaker (1898). The giant axons of *Perinereis cultrifera* are not myelinated by histological standards (Ehlers, 1868). In a paper devoted largely to the earthworm, Stough (1926) described intersegmental macrosynapses or transverse septa in the lateral giant fibres (*Nereis*). Finally, Bullock (1945b, 1948) has recorded action potentials corresponding to the five giant axons of *Neanthes virens.* He concluded that the several giant axons (with the possible exception of the medial pair) conduct impulses independently

of each other, either anteriorly or posteriorly, following tactile or electrical stimulation. Definite regions of the body discharge certain giant fibres only. Hamaker figured an overlapping of the successive giant fibres of the medial pair, and Bullock (1948) suggested that this arrangment permits at least unpolarized functional junctions in series through the cord.

Eunicidae. Giant axons are very large and form a considerable proportion of the nerve cord in the Eunicidae. There is a single large axon in *Eunice* Nerve cells, branches, and other details of the giant axon are unknown.

Arabellidae. Livanoff (1924) and Spengel (1881) have described giant axons in *Arabella.* Five to six large fibres are present in the medio-dorsal region of the nerve cord. Giant nerve cells occur in the anterior ganglia in segments II to XX (Fedorow, 1928; Livanoff, 1924), and according to Spengel (1881) they form multicellular giant axons. The length, course, and arrangement ot giant axons in this genus are by no means firmly established



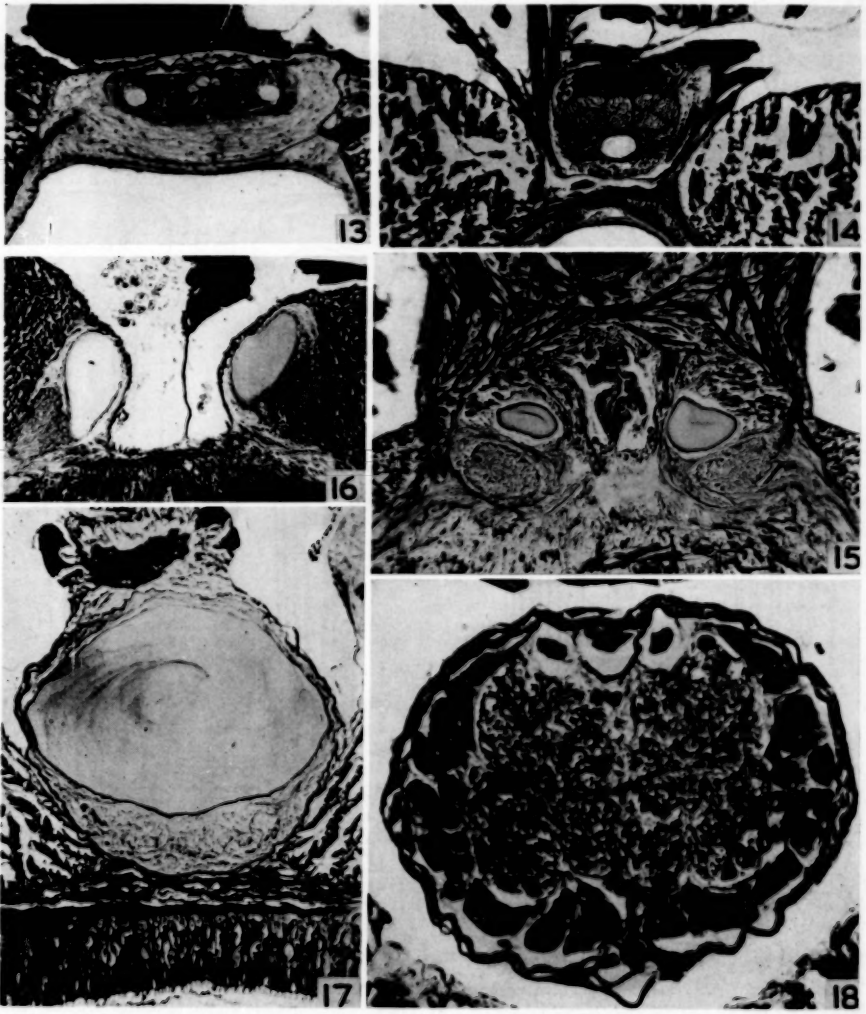
FIGS. 9 TO 12. DIAGRAMS OF GIANT AXONS OF NEREIDS AND LYSARETIDS

Fig. 9. Medial and lateral giant fibres of *Neanthes virens* (based on Hamaker, 1898, and Stough, 1926). Figs. 10 and 11. Antero-posterior and postero-anterior giant fibres of *Halla* and *Aglaurides* (based in large part on Ashworth, 1909). Fig. 12. Single giant axon of *Eunice* (based on several authors).

(many species), *Marphysa*, and *Lysidice* (Jourdan, 1887; Livanoff, 1924; McIntosh, 1877, 1885, 1923; Pruvot, 1885). In *E. rousseaui* Quatrefages (= *E. violacea*), the giant axon extends into the oesophageal connectives (Keyl, 1913), possibly to end in the supraoesophageal ganglia (Figs. 12, 14). Diameters of the nerve fibre in trunk segments are about 100μ in *E. rousseaui* and *E. harassi* Aud. and M.-E (Ehlers, 1868; Keyl, 1913; Nicol, 1947). The diameter is greatest in the anterior segments and decreases posteriorly (McIntosh, 1877). however. Bullock (1948) found that the giant axons are relatively small and inconstant in number. No distinct giant spike potential was recorded, but there was evidence for some rapid pathway in the nerve cord. In another genus, *Drilonereis*, giant axons are absent (Spengel, 1881).

Lumbrinerdiae. Conspicuous large nerve fibres are present in *Lumbrineris* (several species), but there is considerable divergency in descriptions of their number, stemming either from species differences or more probably from incompleteness of

observation. Michel (1899) and McIntosh (1923) mentioned four fibres, two median, one above the other, and two paired, one on either side of the cord. Spengel, 1881). Bullock (1948), however, has confirmed the existence of four giant axons and has shown that they form through-conducting path-



FIGS. 13 TO 18. PHOTOGRAPHS OF TRANSVERSE SECTIONS OF THE NERVE CORDS OF ANNELIDS TO SHOW GIANT AXONS

Silver impregnation. Fig. 13. *Nereis diversicolor*. Five giant axons visible. ×79. Fig. 14. *Eunice harassi*. Single giant axon. ×51. Fig. 15. *Branchiomma vesiculosum*. Pair of giant axons. ×51. Fig. 16. *Sabella pavonina*. Pair of giant axons. ×51. FIG. 17. *Myxicola infundibulum*. Single giant axon. ×79. Fig. 18. Earthworm. Three giant axons in dorsal (upper) part of nerve cord. ×466.

Only one or two nerve fibres have been described by other observers, usually the large medio-dorsal axon (Fedorow, 1928; McIntosh, 1885, 1923; ways. They probably arise from large nerve cells in the anterior ganglia (Fedorow, 1928; Spengel, 1881).

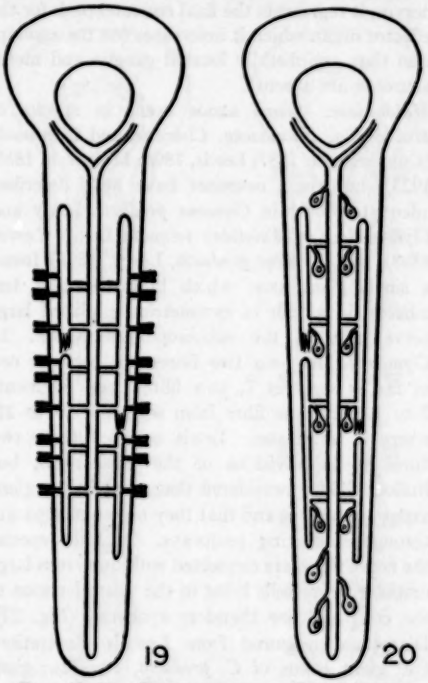
Lysaretidae. Good descriptions are available for the giant axons of two species of lysaretids. This is due in part to the fact that the giant fibre nerve cells are particularly large, thereby facilitating the study of these structures.

Giant axons have been noted in *Halla* by Claparède (1868), Spengel (1881), and Haswell (1886), while Ashworth (1908, 1909) has given a lengthy account of the giant fibres of *H. parthenopeia* Delle Chiaje. The last author found 2 sets of giant fibres: an antero-posterior group arising from 15 to 21 giant nerve cells in the anterior segments; and a postero-anterior group arising from 6 to 8 smaller nerve cells in the posterior segments. The anterior giant cells vary from 30μ to 150μ in diameter, and the axons from 8μ to 40μ. The giant axons are unicellular, do not anastomose with one another, and give off a number of fine branches into the neuropil of the nerve cord. They run long distances in the cord, some of the antero-posterior fibres extending to within 1 or 2 mm. of the posterior end of the animal. These giant axons are not myelinated, in the usual sense of the word. Ashworth (1909) also found that a similar arrangement of giant axons occurs in *Aglaurides fulgida* Savigny (Figs. 10, 11). Giant axons are absent in the parasitic species *Oligognathus bonelliae* Spengel (Spengel, 1881).

Onuphidae. The Onuphidae in general are characterized by a very large axon extending long distances in the nerve cord. Genera which have been examined include *Hyalinoecia*, *Nothria*, *Diopatra*, and *Onuphis* (Bullock, 1948; Livanoff, 1924; McIntosh, 1877, 1923; Pruvot, 1885). The giant axon of *Hyalinoecia tubicola* O. F. Müll. is of extraordinarily large size, 500μ. Very little is known of the giant axons of this family; their simplicity of arrangement and size should make them a profitable subject for neurological study.

Orbiniidae. Giant nerve fibres have been mentioned several times as occurring in this family. According to McIntosh (1923) and Michel (1899), there is a single large dorsal fibre and a pair of discontinuous smaller fibres beneath it in various orbiniids, including *Orbinia* (= *Aricia*). Other authors have described one or two giant fibres in the nerve cord of *Aricidea*, *Naineris*, and *Scoloplos* (Claparède, 1868; Cunningham, 1887; McIntosh, 1877, 1885; Saint Joseph, 1894). These accounts are too fragmentary for any conclusions to be drawn concerning their arrangement and form. Recently Bullock (1948) has recorded from *Haploscoloplos bustorus* two giant spike potentials which are related to two inconspicuous median giant fibres.

Arenicolidae. Giant axons are known to occur in most species of *Arenicola* but are absent in *A. claparedei* Levinsen and in the related genus *Branchiomaldane* (Ashworth, 1903, 1904, 1910a, 1910b, 1911, 1912; Claparède, 1868; Cunningham, 1887; Fauvel, 1899; Gamble and Ashworth, 1898, 1900; Saint Joseph, 1894). Where they occur, there is one fibre anteriorly, two or three in the central body region, and one posteriorly (Figs. 19, 20). All fibres anastomose with one another in each segment; they constitute, therefore, a composite unit. Bullock's record (1948) of a single spike potential from *Arenicola cristata* Stimpson offers confirmation of this arrangement. One or two large nerve cells in each metamere join the giant fibres either directly or by means of commissural branches between the latter; these giant fibre



FIGS. 19, 20. DIAGRAMS OF THE GIANT AXONS OF ARENICOLA

Based on Ashworth (1904) and Gamble and Ashworth (1900). All three fibres anastomose with one another.

cells are 50μ–80μ in diameter. Three pairs of branches proceed from the giant fibres into the peripheral nerves in each segment (Figs. 19, 20). The sheaths of the giant axons of *A. grubei* are slightly osmiophilic (Gamble and Ashworth, 1900). In effect, there is only one giant fibre in the nerve cord; it is subdivided into several strands in each segment and arises from many nerve cells. Since its branches pass directly into the peripheral nerves, it represents the final common path for the effector organ which it innervates (on the assumption that peripherally located ganglia and motor neurones are absent).

Maldanidae. Giant axons occur in species of *Maldanella*, *Nicomache*, *Clymene*, and *Clymenella* (Cunningham, 1887; Lewis, 1898; McIntosh, 1885, 1923), but these neurones have been described adequately only in *Clymene producta* Leidy and *Clymenella* (= *Axiothea*) *torquata* Leidy (Lewis, 1898). In *Clymene producta*, Lewis (1898) found a single giant axon which bifurcates and terminates in a pair of symmetrically placed large nerve cells in the suboesophageal region. In *Clymenella torquata* two fibres are present: one as far as segment 7, two fibres from segments 7 to 19, and one fibre from segments 19 to 22, where it terminates. Lewis believed these two fibres to be divisions of the same axon, but Bullock (1948) considered that two distinct giant axons are present and that they represent separate through-conducting pathways. In both species the nerve fibres are connected with numerous large unipolar nerve cells lying in the ventral region of the cord and are therefore syncytial (Fig. 22). Diameters measured from Lewis's illustrations are: giant axons of *C. producta*, 19μ–32μ; giant fibre cells of *C. torquata*, 20μ–52μ. Lewis emphasized that the neuroplasm of giant fibre cells and giant fibres become continuous with one another. The axons have a myelin sheath that blackens with osmic acid.

Ampharetidae. Giant axons occur in the ampharetids *Melinna*, *Phyllocomus*, *Amphicteis*, and *Ampharete*, either in the thorax alone or in the thorax and abdomen (Cunningham, 1887; Fauvel, 1897; McIntosh, 1885, 1923). They apparently arise from giant nerve cells in the thoracic region, and since these cells are numerous and the fibres few in number, the fibres may be syncytia connected with a number of cells Finally, the variation in the number of giant fibres at several levels indicates that they branch and anastomose with one another. If the interpretations given here are correct, then the giant axons of the Ampharetidae resemble those of the Maldanidae rather closely, with the exception that in the former family the giant fibre cells are localized in the anterior segments.

Capitellidae. The several accounts dealing with the giant fibres of the capitellids reach sizeable proportions, but despite their magnitude the conclusions which can be formulated are very slender. Giant nerve fibres running through the greater part of the nerve cord are widespread in members of this family. There are one to four giant axons in different parts of the nerve cord, and they are apparently syncytia connected with numerous large nerve cells either widely distributed in the cord (*Mastobranchus*) or aggregated in the anterior region (*Notomastus*). Cross connexions between the two lateral fibres have been observed in *Mastobranchus* (Fig. 21), and it is possible that in some of the other genera the giant fibres are connected with one another (Claparède, 1863, 1868; Cunningham, 1887; Cunningham and Ramage, 1888; Dehorne, 1935; Eisig, 1887; Friedländer, 1889; Keferstein, 1863; Livanoff, 1924; McIntosh, 1877, 1885, 1923; Saint Joseph, 1894). The fibres vary considerably in diameter in different regions, and in *Mastobranchus* there are clearly marked constrictions arranged segmentally (Fig. 21). This form also has a very well developed myelin sheath (Friedländer, 1889), probably the best developed in the Annelida, but the occurrence of myelin sheaths in other genera has not been proven.

Spionidae. Giant nerve fibres are well developed in this family. One or two axons occur in *Polydora*, *Prionospio*, *Scolelepis*, *Nerine*, *Laonice*, and *Pygospio* (Attems, 1903; Claparède, 1868, 1873; Cunningham, 1887; Cunningham and Ramage, 1888; Jacobi, 1883; Langerhans, 1880; McIntosh, 1885, 1923; Michel, 1898, 1899). They have diameters of 22μ–30μ in species of *Polydora* (Jacobi, 1883) but are said to be enormous in *Nerine cirratulus* Delle Chiaje (Michel, 1899). Langerhans (1880) observed that the giant axons of *Prionospio steenstrupi* Malmgren originate in the supraoesophageal ganglia and are myelinated, and Michel (1899) stated that those of *N. cirratulus* show regular segmental alterations in diameter. According to McIntosh (1923), the two giant axons in the anterior segments of *N. foliosa* Aud, and M.-E. fuse to form a single giant axon more

posteriorly. The nerve cells of these fibres are not known.

Terebellidae. Giant axons in this family show a considerable amount of variation and are absent or small in *Amphitrite*, *Terebellides*, and *Thelepus*, and well differentiated in *Eupolymnia* (=*Polymnia*) (diameter 28μ), *Pista*, and *Lanice conchilega* Pallas (Bullock, 1948; Claparède, 1873; Cunningham, 1887; Dehorne, 1935; McIntosh, 1885, 1923; Saint Joseph, 1894; Steen, 1883). Steen (1883) found that the two giant axons in the anterior nerve cord of *Terebellides* fuse to form one axon extending posteriorly. According to Dehorne (1935), the single large axon of *Lanice* is a syncytium connected with many large nerve cells.

Sabellariidae. A detailed study of the giant axons of sabellariids has not been undertaken, but it would appear that they are as well developed in the Hermelliformia as in the Sabelliformia and represent an adaptation to a similar sedentary mode of life. The nerve cord of *Sabellaria* is built on a ladder-like pattern, and each half of the cord contains a large nerve fibre (Cunningham, 1887; McIntosh, 1877, 1885, 1923; Meyer, 1887, 1888; Michel, 1899).

Magelonidae. McIntosh (1878) and Cunningham (1887) have described a large axon in *Magelona*. According to McIntosh two giant axons, entering the nerve cord from the oesophageal connectives, fuse together in segment VII to form a single giant fibre extending to the posterior end of the animal. The especially large nerve cells in the supra-oesophageal ganglia of *Magelona* (McIntosh, 1878) may be worthy of investigation as the source of these giant axons.

Sabellidae. There has been general agreement that giant nerve fibres attain particularly large

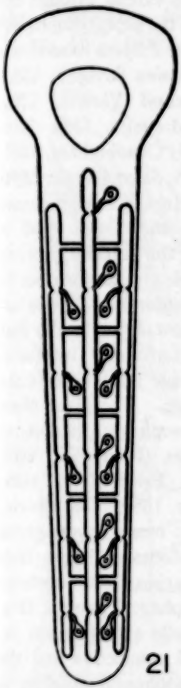


FIG. 21. DIAGRAM OF THE GIANT AXONS OF MASTOBRANCHUS
Based on Friedländer, 1889

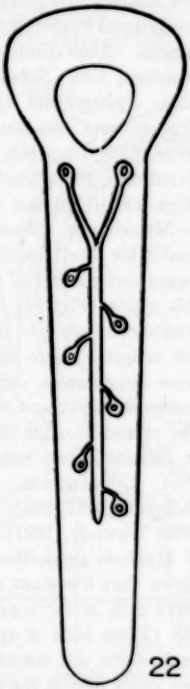


FIG. 22. DIAGRAM OF THE GIANT AXONS OF CLYMENE
(Lewis, 1898)

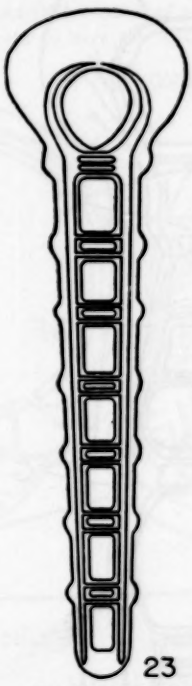


FIG. 23. DIAGRAM OF THE GIANT AXONS OF SABELLA AND SPIROGRAPHIS

FIG. 24. DIAGRAM OF THE GIANT AXON OF MYXICOLA INFUNDIBULUM
(Sources in text)

sizes in this family and that they occur in all species. They consist, in general, of very large fibres which extend the entire length of the nerve cord. Two separate patterns can be distinguished, however, which are related to the configuration

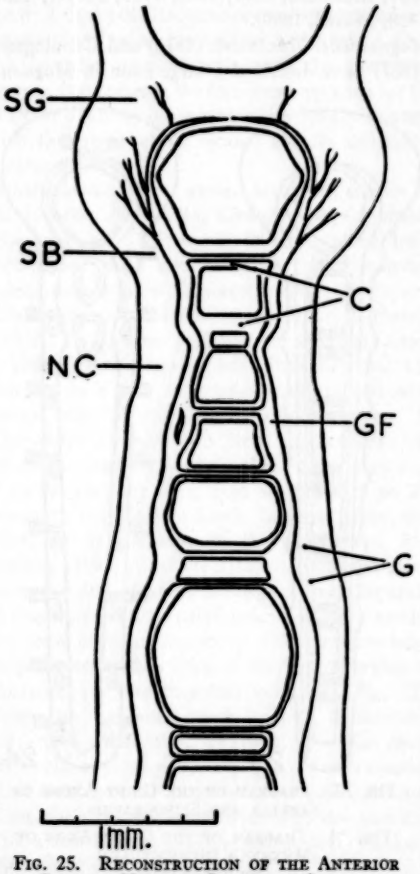


FIG. 25. RECONSTRUCTION OF THE ANTERIOR CENTRAL NERVOUS SYSTEM OF SABELLA PAVONINA

Somewhat diagrammatic. SG, supraoesophageal ganglia; SB, suboesophageal ganglion; NC, nerve cord; GF, giant axon; G, cord ganglia; C, commissures (original).

of the nerve cord. In the sabellids proper (Sabellinae, Fabriciinae) the nerve cord is double and conforms to the typical ladder pattern. A large fibre lies in each half of the nerve cord (*Spirographis*, *Sabella*, *Branchiomma*, *Chone*, *Euchone*, *Bispira*, *Laonome*; Claparède, 1873; Cunningham, 1887; Evenkamp, 1931; McIntosh, 1877, 1885, 1918, 1923; Meyer, 1887, 1888; Pruvot, 1885; Saint Joseph, 1894; Spengel, 1881; Thomas, 1940). In *Spirographis* the two fibres are connected together in the commissures of the thoracic region (Claparède, 1873), and in *Sabella* cross anastomoses occur between the two fibres in the two commissures of each segment of the body (Nicol, 1947). Moreover, in *Sabella*, *Spirographis*, *Branchiomma*, and *Euchone* the giant axons extend through the oesophageal connectives into the supraoesophageal ganglia. Axon diameters are: *Bispira volutacornis* Montagu, 120μ; *Sabella pavonina* Savigny, 120μ-200μ; *Spirographis spallanzanii* Viviani, 120μ; *Branchiomma vesiculosum* Montagu, 135μ (Brunotte, 1888; Claparède, 1873; Cunningham, 1887; Evenkamp, 1931; Nicol, 1948; Saint Joseph, 1894) (Figs. 15, 16, 23 and 25). In the Eriographinae (=Myxicolinae, *Myxicola*), the nerve cord is double for short stretches in the anterior thoracic region and consists of a single strand posterior to this region (Fig. 24). In conformity to this arrangement there are two giant fibres in the first few setigers, where they interconnect by transverse anastomoses, and a single large fibre in the posterior thorax and abdomen. The giant fibres also extend into the supraoesophageal ganglia, as in the other two subfamilies (Claparède, 1870, 1873; Cunningham, 1887; Friedländer, 1889; McIntosh, 1877, 1923; Meyer, 1887, 1888; Pruvot, 1885; Wawrzik, 1892). In a recent investigation of *Myxicola infundibulum* Montagu, it has been shown that the giant axon arises from two large nerve cells in the supraoesophageal ganglia (Fig. 24). From each of these cells a large axon extends down one oesophageal connective and the two axons fuse in the suboesophageal ganglion to form the giant fibre (up to 1.7 mm. in diameter) lying in the nerve cord. Moreover, the giant axon is in protoplasmic continuity with many small nerve cells along the entire length of the cord and gives rise to several branches entering the peripheral nerves in each segment. The peripheral branches themselves are very large (up to 85μ in diameter) and directly innervate the relatively massive longitudinal musculature of the animal (Figs. 17, 24, 26). A small species, *M. aesthetica* Claparède, appears to have essentially the same structure (Nicol, 1947; Nicol and Young, 1946). In general, the giant axons of sabellids are surrounded by a distinct cellular and fibrous sheath (Claparède, 1873; Evenkamp, 1931; Friedländer,

1889; Wawrzik, 1892). Friedländer (1889) stated that the giant axon sheath of *M. infundibulum* "stained" slightly with osmium tetroxide, and Nicol (1948) detected a thin fatty layer, which coloured with Sudan black, next to the giant axon.

Serpulidae. In this family, which is closely related to the Sabellidae, axons in the nerve cord are equally greatly hypertrophied. A pair of giant fibres has been found in nearly all forms examined, namely *Protula*, *Serpula*, *Pomatoceros*, and *Hydroides* (Claparède, 1873; Cunningham, 1887; McIntosh, 1877, 1885, 1918, 1923; Meyer, 1887, 1888; Pruvot, 1885; Thomas, 1940; Treadwell, 1891). Each half of the nerve cord contains a large nerve fibre, which extends from the suboesophageal ganglion to the posterior end of the body. According to Claparède (1873), the giant fibres of *Protula intestinum* L. extend into the oesophageal connectives as well.

Other polychaete families. The occurrence and arrangement of giant axons in other families of polychaetes are based on less extensive evidence. Claparède (1868) described a large central fibre in the nerve cord of *Syllis vittata* Grube, but this has not been confirmed, and it is probable that giant axons are absent in the Syllidae (Malaquin, 1893; Perrier, 1897). Vejdovský (1878) is the only author who has described a giant fibre in *Tomopteris* (Tomopteridae). McIntosh (1925), on the other hand, considered that they are absent in this family. Since tomopterids are small free-swimming pelagic forms, it would be expected that they would lack the defensive mechanisms available to tubicolous and burrowing species. *Polyodontes* (Polyodontidae) and *Goniada* (Goniadidae) appear to have two inconspicuous giant axons in the nerve cord (Ehlers, 1868; McIntosh, 1877, 1885). In the Disomidae, Allen (1904) found two large fibres in the nerve cord of *Poecilochaetus serpens* Allen, each about 82μ in diameter. Ashworth (1901) believed that they are absent in *Scalibregma inflatum* Rathke (Scalibregmidae), and McIntosh (1923) could find none in *Cistenides* (=*Cystarides*) *hyperborea* (Pectinariidae). They are apparently absent in certain cirratulids (*Cirratulus cirratus*, O. F. Müll. (Cunningham, 1887)), or are small in size (*Cirriformia* (=*Audouinia*) (Claparède, 1873; McIntosh, 1923); *Cirratulus*

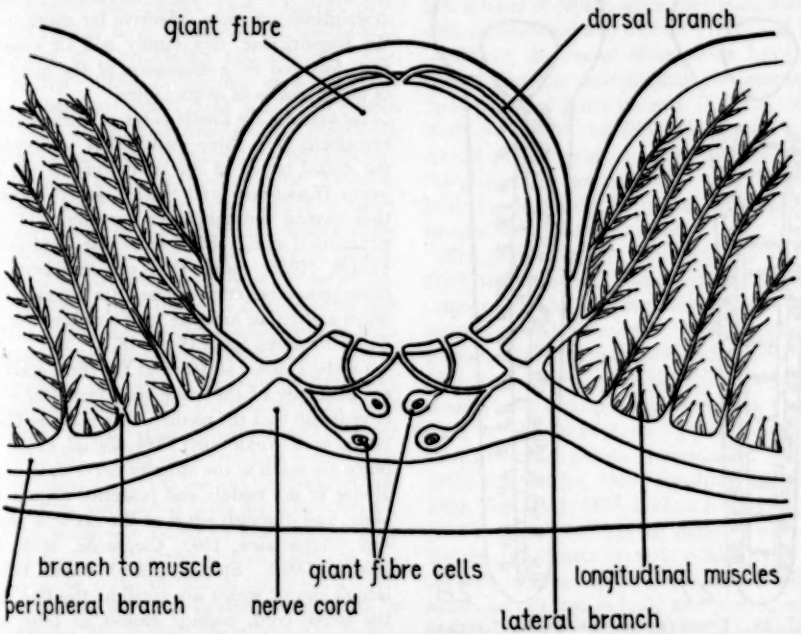
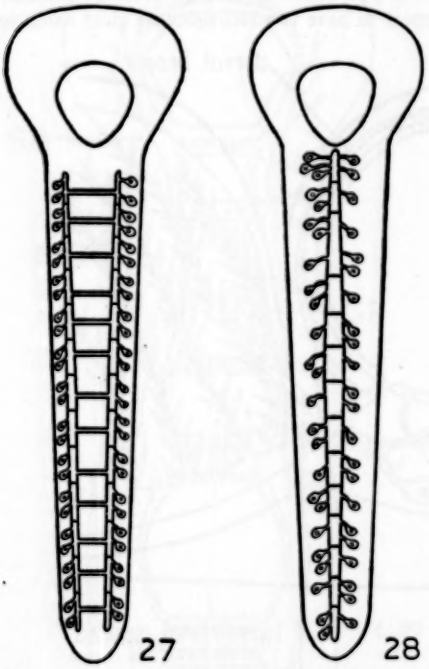


FIG. 26. DIAGRAM OF THE NERVE CORD, GIANT FIBRE AND BRANCHES OF MYXICOLA INFUNDIBULUM, AS SEEN IN TRANSVERSE SECTIONS

(Michel, 1898)). McIntosh (1923) has described, however, a large nerve fibre lying dorso-medially in the nerve cord of *Dodecaceria concharum* Oersted (Cirratulidae). Giant fibres are present in *Stylarioides* (Flabelligeridae), in which Cunningham (1887) found a giant fibre in each half of the nerve cord. They are inconspicuous or absent in *Phyllodoce* (Phyllodocidae) (Cunningham and Ramage, 1888; Michel, 1899). McIntosh (1885) has described a single giant axon in species of



FIGS. 27, 28. DIAGRAMS OF THE PAIRED LATERAL GIANT AXONS AND THE SINGLE MEDIAN GIANT AXON OF LUMBRICUS

(Sources cited in text)

Amphinomidae (*Hermodicë* and *Eurythoë*). Perrier (1897) stated that there are no giant fibres in the Opheliidae, but several small fibres have been described repeatedly in various species of this family (Cunningham, 1887; Kükenthal, 1887; McIntosh, 1877, 1923; Meyer, 1882; Vejdovský, 1878). Such fibres, although noticeably larger than the other nerve fibres in the cord, are still of quite small size.

Myzostomida. In this aberrant and parasitic group Nansen (1887) has described large nerve fibres, which he compared with the giant axons of other chaetopods. Two kinds of large axons occur in *Myzostoma*: (1) groups of longitudinal fibres extending through the ganglionic mass; (2) 6-7 pairs of large unicellular axons, each of which springs from a large nerve cell, decussates with a corresponding fibre, and enters a peripheral nerve. The significance of these neurones is obscure.

Oligochaeta

Following Claparède's original description in 1861, numerous investigations have been made of the giant axons of the Oligochaeta. Since the descriptions are more extensive for giant axons of the Lumbricidae, this family will be considered first, followed by a discussion of the giant axons of other species of oligochaetes.

Giant axons of the Lumbricidae. There is common agreement that three giant fibres are present in the dorsal region of the nerve cord of the earthworm (*Lumbricus* and related genera) and that they extend throughout the greater part of this structure (Leydig, 1864a; and subsequent authors). Stough (1926) found that supernumerary giant fibres sometimes occur: these arise from the normal fibres and either arborize in the neuropil or rejoin the giant fibres again (Figs. 18, 27, 28).

Leydig (1864a) stated that the three giant fibres are generally of the same size; but later workers have found that the median fibre is larger than the lateral ones (Vejdovský, 1884; Vignal, 1883). The fibres are small in the anterior nerve cord, increase in size in the middle and posterior regions of the body, and diminish again at the extreme posterior end (Cerfontaine, 1892; Claparède, 1869; Friedländer, 1888). Stough (1926) found that the lateral giants, which are small at the two ends of the nerve cord, become almost as large as the median giant in the middle body region and that, on the average, the sum of the diameters of the two lateral fibres equals the diameter of the median fibre.

Friedländer (1888, 1889, 1894) gave the first description of the nerve cells of these fibres, and he showed that they are syncytial structures; further details were given by Cerfontaine (1892), Keyl (1913), Stough (1926), and Smallwood and Holmes (1927). There are two to six large nerve cells and a number of smaller cells that connect either with the median or with the two lateral fibres in each segment. Stough (1926) found a considerable amount of fusion of the processes of the cells before they reach the median giant axon.

The question of anastomoses among the dorsal giant axons of the earthworm has been a controversial one for a long time, and it is only recently that this aspect has been clarified. Claparède (1869) denied that the giant fibres of the earthworm anastomose with one another, but Leydig (1864a, 1864b), Friedländer (1888, 1894), Cerfontaine (1892), Krawany (1905), and Stough (1926) have found connexions between the giant fibres. Cerfontaine and Stough, in particular, have shown that the two lateral giants are connected by a transverse anastomosis in each segment and are independent of the median axon. Recent physiological studies have confirmed the anatomical descriptions of Cerfontaine and Stough. The latter author (1930) discovered, as a result of cutting either the median giant or the two lateral giants, that these structures possess functional peculiarities distinguishing them from one another. He concluded that the median fibre conducts posteriorly while the two lateral fibres conduct anteriorly; fusion of the lateral and median fibres is clearly impossible on this basis. Eccles, Granit, and Young (1933), from a study of the action potentials recorded from the nerve cord, showed that the giant fibres can conduct equally well in both directions when stimulated electrically. These authors found two large spike potentials differing in amplitude and velocity, the smaller spike being transmitted with a velocity greater than the larger spike potential. They suggested that their results could be explained on the basis of these anatomical facts: that the two lateral fibres are connected together by transverse junctions and conduct as a unit and that their combined cross-sectional diameter is about equal to that of the median fibre. They concluded that the smaller, faster spike is conducted by the median giant and the larger, slower spike by the two lateral giants. This work has been extended by Bullock (1945) who found that the smaller and faster spike was abolished by sectioning the median fibre, and that the two lateral fibres conduct as a unit independently of the median giant axon. Rushton's conclusions (1945a) were similar. He was successful in cutting all three giant axons, moreover, and demonstrated that the faster wave dropped out after section of the median giant and the slower wave after section of both lateral giants; alternate hemisection of the cord, right and left, increased the latent period of the lateral fibre response without abolishing it. He concluded from this evidence, that the lateral fibres are connected with each other at least once in every ten segments.

Perhaps the most peculiar feature of the giant axons of the earthworm is the fact that they are not continuous structures but are subdivided in each segment by oblique septa or partitions. These septa were probably first observed by Leydig (1886), and they have been described and figured subsequently by Stough (1926) and Young (1936). Stough pointed out that they provide a large area of contact between the axonic segments of two consecutive ganglia and suggested that they contain a layer of myelin since they stain with osmic acid. Smallwood and Holmes (1927) and Bullock (1945), by the use of silver stains, have demonstrated that the neurofibrillae are interrupted at these places of junction; and Taylor (1940), in a study of sheath birefringence, found that the optical properties of the segmental partitions of the giant fibres are similar to those of the myelinated axon sheath, indicating similarity in their composition and ultrastructure.

The giant axons are surrounded by a relatively thick fibrous sheath composed of concentrically arranged fibrils and containing small nuclei of supporting cells (Claparède, 1869; Leydig, 1864a; Nansen, 1887; Vignal, 1883; and others). Moreover, the sheath is lamellated and seems to include a more homogeneous inner layer closely applied to the giant axon. It has already been stated that this sheath is myelinated (Claparède, 1869; Friedländer, 1888; Schultze, 1879; Stough, 1926; Vejdovský, 1884, 1892; and others). Taylor (1940), from birefringence data, concluded that the sheath ultrastructure is qualitatively similar to that of frog sciatic nerve fibres, with lipid molecules oriented radially and protein molecules tangentially. He found that the relative sheath thickness increases with decrease in fibre diameter below 40μ and that zero birefringence occurs at fibre diameters of 10μ–12μ, some of the fibres in this range being metatropic.

No clear description of the branches and afferent connexions of the giant fibres exists. Bullock (1945), from an oscillographic study of the giant fibres of *Lumbricus*, stated that "they are apparently on the efferent side of the reflex arc, but are not probably the final common path." Since all these fibres conduct in both directions, as the result of electrical as well as natural stimulation, Bullock suggested that they bring about different muscular responses. That is, the fibres are con-

nected to different efferent neurones, anterior stimulation leading to one type of response by way of the median fibre, posterior stimulation to another type of response by way of the lateral fibres. Friedländer (1888) saw some type of connexion between ventral branches of the median fibre and fibres extending into the peripheral nerves; Haller (1889) and Cerfontaine (1892) described branches entering the peripheral nerves. Smallwood and Holmes (1927) mentioned motor branches, but it is difficult to determine whether these authors were referring to branches of the giant fibres or to separate motor neurones. A further investigation is required of this difficult subject before conclusions are possible.

Somewhat more is known of the afferent paths to the giant fibres. Stough's conclusion (1930) has been mentioned earlier, namely, that the median giant conducts posteriorly, and the lateral giants anteriorly, as the result of tactile stimulation. Bullock (1945) and Rushton (1946), from oscillographic records, have shown that the median giant must be connected to sensory neurones in the anterior region, and the lateral giants to sensory neurones in the posterior region of the body. In an intermediate, central region afferent neurones reach all three giant fibres. According to Smallwood (1930) and Smallwood and Holmes (1927), incoming sensory fibres, on entering the neuropil, establish synaptic relations with the giant fibres either directly or through branches of the giant fibre cells.

Rushton (1945b) has pointed out that the form of startle response shown by the earthworm in nature is more complex than that revealed by electrical studies in the laboratory. On a rough surface, where the setae can grip, the responses are of two kinds: when the region anterior to the fortieth segment is touched, the tail is anchored and the head withdrawn; when the posterior region is touched, the head is fixed and the tail brought forwards. The retraction associated with the median axon is accompanied by a characteristic flattening of the tail and a directing of its setae forwards. This reaction is well adapted to grip the sides of the burrow when the anterior end is emergent. Moreover, the presence of the tail in the burrow causes some switching over of the giant fibre systems. If a worm, protruding from its burrow, is grasped behind the fortieth segment, it gives the median fibre response. These several reactions reveal a considerable diversity of central connexions.

Besides the three dorsal giant fibres, a pair of smaller ventral giant axons has been described in the earthworm (Friedländer, 1888). They are surrounded by an osmiophilic sheath (Stough, 1926) and are divided by transverse septa like the dorsal giants (Smallwood and Holmes, 1927). Nerve cells in the ventral region of the cord send processes to these ventral giant fibres, to the neuropil, and into the peripheral nerves (Smallwood, 1930; Smallwood and Holmes, 1927). Bullock (1945) picked up action potentials smaller than those of the dorsal giants and suggested that these might be due to the ventral giant axons.

Giant axons of other Oligochaetes. Much less is known of the giant fibres of other families of oligochaetes. Frequently three are present, as in the earthworm, but in the Megascolecidae some species constantly have four of these axons (Beddard, 1883; Keyl, 1913; Vejdovský, 1878), and in some species of the Naididae (*Nais*) and Enchytraeidae (*Pachydrilus*, *Enchytraeus*), two axons present anteriorly fuse together to form a single axon extending posteriorly in the nerve cord (Leydig, 1864b; Michaelsen, 1886; Vejdovský, 1878). The giant axons of the Glossoscolecidae appear to resemble those of the Lumbricidae (Benham, 1887; Friedländer, 1894; Perrier, 1874; Vejdovský, 1878). Hönig (1910) found three giant axons in *Criodrilus*; these appear to be connected with nerve cells throughout their course in the nerve cord. Keyl (1913) found ventral processes arising from the three giant fibres of *Alma nilotica* and, with more or less certainty, traced these processes to nerve cells lying in the ventral region of the nerve cord.

GIANT AXON PATTERNS IN THE ANNELIDA

The descriptions of giant axons of annelids, although far from complete, show that these structures display the greatest diversity and a baffling complexity. They differ so greatly from one another in different families and even in different genera of the same family that it is difficult to establish any anatomical categories in which they can be classified, even for convenience of description and for summary of their common characteristics. The following arbitrary division of giant axons into intrasegmental and intersegmental giant axons is presented for the purpose of discussion.

Intrasegmental giant axons

In many species of polychaetes, giant axons extend long distances in the nervous system, either throughout the length of the nerve cord or through many segments. In a few species, however, nerve fibres of exceptionally large size are confined to single segments of the animal; such fibres always enter the peripheral nerves. The clearest examples of this arrangement are afforded by *Euthalenessa dendrolepis* (Sigalionidae) and *Lepidasthenia elegans* (Polynoidae), described above. In these two species a process of a large nerve cell in each segment crosses the cord and passes out into the body wall. Similar intrasegmental fibres that enter the peripheral nerves occur in *Aphrodita* and *Hermione*, but their cell bodies are unknown; *Ichthyotomus* likewise possesses intrasegmental unicellular giant axons, described above. In *Neanthes virens*, a pair of cells in each neuromere gives rise to two fibres which fuse together and then establish contact with a pair of intersegmental giant fibres before passing into the peripheral nerves on either side of the nerve cord. This arrangement of intrasegmental giant axons is very similar to that occurring in the crayfish and the prawn (Holmes, 1942; Johnson, 1924; Wiersma, 1947), where peripherally directed motor axons, which arise from the anastomosis of two neurones, synapse with giant fibres running through the nerve cord. As in the crayfish, the intrasegmental giant fibres of *Neanthes* are probably motor axons which carry impulses from the lateral giant fibres to the longitudinal muscles. Eisig (1906) regarded the intrasegmental giant axons of *Ichthyotomus* as sensory neurones. As a general rule, however, afferent fibres in the Annelida usually arise peripherally at the body surface, and it is probable that these large peripheral fibres in *Ichthyotomus* are motor axons. They are probably motor axons in the Aphroditidae, Sigalionidae, and Polynoidae as well; but there is no indication that they bear any relation to the intersegmental giant fibres in *Euthalenessa* and *Lepidasthenia*. In fact, intersegmental giant axons do not occur at all in *Aphrodita* and *Hermione*, where intrasegmental giant fibres appear to be present (Cunningham, 1887; Rohde, 1887).

Intersegmental giant axons

Giant axons that extend long distances in the central nervous system are found in nearly all oligochaetes and in many polychaetes and, in terms of size, are enormously developed in species of the Eunicidae, Lumbrineridae, Onuphidae, and in the Sabelliformia. They are hypertrophied also in the sedentary Sabellariidae. Unfortunately, few actual measurements of these structures are available; most authors have merely recorded the fact that they are enormous, large, medium-sized, or small in any particular species.

Myxicola infundibulum has the largest nerve fibre known in the animal kingdom: in some specimens it reaches a diameter of over 1.5 mm. In *Sabella* and *Branchiomma* the fibres have diameters up to 200μ. These three species are about 15 cm. long. In smaller sabellids, 3 cm. long or less, the giant axons are correspondingly smaller. In *Myxicola aesthetica*, for example, a species about 2 cm. long, the maximal diameter of the giant axon is about 40μ; and in *Laonome kroyeri*, about 3 cm. long, the fibres are 70μ–80μ in diameter (Evenkamp, 1931). In the Disomidae (*Poecilochaetus serpens*) they are about 83μ (Allen, 1904), and in the Arenicolidae (*Arenicola grubei*) they are 100μ–300μ in the living state, according to Gamble and Ashworth (1900). (These dimensions certainly are excessively large. St. Joseph (1894) gives a diameter of 29μ for the giant axons of *A. marina*, and in their illustrations Gamble and Ashworth depict giant axons with diameters of 22μ–43μ.) They are small in the Nephtyidae, as, for example, in *Nephtys caeca*, 8μ–14μ (Schack, 1886). Several authors have stated that they are especially large in some spionids (Cunningham, 1887; McIntosh, 1877); but no representative measurements are available. Jacobi (1883) gives diameters of 22μ and 30μ for *Polydora ciliata* and *P. quadrilobata*, respectively, and Claparède (1868) gives 48μ for *Nerine cirratulus*. Claparède (1868) and Ashworth (1909) have stated that the giant fibres of *Halla parthenopeia* (Lysaretidae) are 8μ to 40μ in diameter. The "giant" axons of the Glyceridae are, in fact, rather small, being about 16μ–29μ in *G. convoluta* (Nicol, 1947; St. Joseph, 1894). The measurements available are too few to permit many correlations to be drawn between the size of the animal and the size of the axons or the function of the fibres, but it is probably significant that they are well developed in many sedentary, tubicolous, or burrowing species. They are large in all the sedentary Sabellariidae, Serpulidae, and Sabellidae, in the burrowing Arenicolidae and Disomidae, and in other polychaetes that have burrowing or tubicolous habits, as, for example, *Eunice*, *Hyalinoecia*,

and *Nereis*. On the other hand, giant axons appear to be absent in short and broad forms physically incapable of retraction by end-to-end contraction, as, for example, *Aphrodita*, and in the small and actively swimming syllids and tomopterids. Among the oligochaetes, giant nerve fibres are relatively enormous in the tubificid *Branchiura sowerbyi* Beddard (Stephenson, 1912). Keyl's (1913) measurements for the giant axons of *Lumbricus terrestris* (middle segments) are: median fibre, 90μ x 114μ; lateral fibres, 50μ x 62μ; and for the posterior segments of *L. communis* (? = *Allolobophora caliginosa* Savigny), median fibre, 12.5μ; lateral fibres, 7μ (Keyl, 1913).

In the Sabellidae giant axons are relatively large in all species examined, and their absolute size is restricted only by the size of the animal: obviously a species like *M. aesthetica*, 1 mm. in diameter, must contain a smaller giant axon than its larger relation, *M. infundibulum*, in which this fibre attains a diameter of 1 mm. or more. These fibres also vary greatly in diameter in different parts of the nervous system. The giant axons of *M. infundibulum* and *M. aesthetica* are small in the supraoesophageal ganglia, increase in size in the oesophageal connectives, reach greatest diameters in the thorax, and taper off in the abdomen. Also, in *M. infundibulum*, the fibre changes greatly in diameter within each segment, bulging out in the centre of a segment and becoming constricted intersegmentally. Similar segmentally arranged constrictions and dilations have been noted in the polychaetes *Nerine cirratulus* (Spionidae) (Michel, 1899) and *Mastobranchus* (Capitellidae) (Friedländer, 1889); and in the oligochaete *Lumbriculus variegatus* O.F. Müll., the three giant axons are stated to be constricted at intervals (Vejdovský, 1878). Evenkamp (1931) found that the two giant fibres of *Laonome kroyeri* (Sabellidae) are very small in the oesophageal connectives, about 3μ, and then gradually increase in diameter to about 70μ–80μ in the nerve cord. Claparède (1873) has stated that in *Spirographis spallanzanii* (Sabellidae) each of the two fibres is 35μ wide in the oesophageal connectives, increases to 100μ in the suboesophageal region, and becomes 180μ wide in the nerve cord. In *Eunice rousseaui* (Eunicidae), Keyl (1913) found that the giant fibre has a diameter of about 40μ in the suboesophageal region and increases posteriorly to about 100μ (mean figures). The fibre also varies considerably in shape in this species, being flattened laterally within the connectives and more rounded within the ganglia. In *M. infundibulum* (Sabellidae), the giant axon increases greatly in diameter as the animal shortens, and probably a similar change in diameter occurs in the giant axons of all species that can contract.

It is definitely known that these axons extend throughout the nerve cord in all species of sabellids (and probably serpulids) that have been examined closely. They also run through most trunk segments in *Neanthes* (Hamaker, 1898), *Arenicola* (Gamble and Ashworth, 1898), in *Mastobranchus* (Friedländer, 1889), in some polynoids and sigalionids (Rohde, 1887), in the maldanid *Clymenella* (Bullock, 1948), and in all oligochaetes that possess these nerve fibres. In some species they extend into the supraoesophageal ganglia as well, namely, in *Myxicola* and *Spirographis* (Claparède, 1873), *Sabella* (St. Joseph, 1894), *Branchiomma* (Brunotte, 1888), *Euchone papillosa* (Evenkamp, 1931) and probably other sabellids, in *Neanthes* (Hamaker, 1898), and in *Euthalenessa dendrolepis* (Rohde, 1887). In other species the giant axons may have a more restricted course and extend through part of the nerve cord only. In the polynoid *Lepidasthenia elegans* they disappear about 6 segments from the posterior end, but it is possible that they continue further caudally than this level, as fine fibres that are difficult to differentiate (Rohde, 1887). However, there are certain postero-anterior giant fibres in *Lepidasthenia elegans* that arise from nerve cells lying between segment 16 and the third last segment; these fibres obviously have a very restricted course. In *Halla parthenopeia* the anterior nerve cells of the giant fibres lie in the first few ganglia: only the largest fibres reach the posterior end of the animal; the others successively taper off and disappear in the neuropil at more anterior levels (Ashworth, 1909).

UNICELLULAR AND MULTICELLULAR GIANT AXONS AND NEURONAL FUSION

Giant axons in the Annelida can be divided quite sharply into the two categories of unicellular and multicellular giant axons, according to the number of cell bodies joining them. Only the intersegmental giant axons will be considered.

Unicellular giant axons

In a few species it is known that the giant axons are unicellular, each fibre arising from a single

nerve cell and being anatomically independent of the other giant axons. The best known case is *Halla*, but a similar arrangement occurs in *Aglauri-des* (Ashworth, 1909). In *Halla* (Lysaretidae) each giant fibre is the process of one nerve cell and remains separate from the other giant fibres in its course through the nerve cord. Unicellular giant fibres also occur in the Sigalionidae (Rohde, 1887). In *Euthalenessa dendrolepis* there are five giant axons, each of which arises from a cell in the anterior nerve cord and extends towards the posterior end of the body. Large nerve cells also occur in most segments behind the sixteenth, and the single process of each of these cells runs anteriorly in the nerve cord. Antero-posterior giant fibres arising from single nerve cells also occur in *Sigalion squamatum*.

Multicellular giant axons

There are enough descriptions now available to show that multicellular giant axons are of widespread occurrence in the Annelida. The classical example is the earthworm (*Lumbricus* and allied genera), in which the median and the two lateral giant fibres receive the processes of nerve cells throughout their length. The arrangement is complicated in these animals by the fact that the three giant axons are each divided into segments by transverse septa in each ganglion. But, since there are several cells in each ganglion connected with the giant axon, the giant axon segments are themselves syncytia (Cerfontaine, 1892; Friedländer, 1888; Smallwood and Holmes, 1927; Stough, 1926; Young, 1936). Multicellular giant axons that receive the processes of nerve cells in each segment also occur in the capitellid *Mastobranchus* (Friedländer, 1889), in the maldanids *Clymenella* and *Clymene* (Lewis, 1898), and in *Arenicola* (Gamble and Ashworth, 1898). Transverse septa have not been described in these forms. In the sigalionid *Euthalenessa*, one giant axon arises from a pair of cells in the supraoesophageal ganglia (Rohde, 1887). Finally, in *Myxicola* the giant axon arises from two nerve cells in the supraoesophageal ganglia and, in addition, is connected with at least ten nerve cells in each segment.

Axoplasmic fusion is a very difficult matter to prove when the neurones concerned are rather small. Although many authors have described multicellular axons in the Annelida, there are few descriptions which actually present evidence that complete fusion of axoplasm occurs, either between different giant axons or between a giant axon and several nerve cells. In *Neanthes virens*, Hamaker (1898) stated that the intrasegmental giant axons undergo complete anastomosis in the centre of the cord, with fusion of neuroplasm and probable exchange of neurofibrillae. Lewis (1898) claimed that in *Clymenella* and *Clymene* the axoplasm of the cell processes fuses with that of the giant axon. It is impossible to prove by cutting the nerve cord that the giant axons of the earthworm are multicellular structures, since the giant fibres are segmental in this animal, and degeneration, if it occurred, would not be expected to extend past the septal barrier in each segment. In fact, after transection, the giant axons do not degenerate but actually regenerate and grow together from their cut ends (Bovard, 1918b; Hall, 1921). *Myxicola infundibulum* appears to be the only species of the Polychaeta in which the giant axon has been cut in order to determine if either of the separated pieces will degenerate; and evidence for the multicellular origin of that nerve fibre has been obtained by this means (Nicol 1948; Nicol and Young, 1946).

Fusion of neurones is not unknown in the vertebrates. Harrison (1913) has described anastomosis of nerve fibres in tissue culture of frog embryo tube; and Speidel (1935) found that growing tips of nerve fibres in the living tail fin of frog tadpoles fuse with one another, though he qualified this description by stating that fusion is between the outer more "plastic" protoplasm and does not involve the inner, more "viscous" axes of the fibres. Multicellular giant axons also occur in other invertebrate phyla. The two medial giant axons of the prawn are probably syncytia, since they fail to degenerate after section (Holmes, 1942). Young (1936b) has shown that in decapod cephalopods each of the giant axons in the stellar nerves probably arises from several hundred nerve cells in the stellate ganglion.

It is not improbable that the syncytial nature of these giant axons is concerned with the necessity of maintaining such large masses of axoplasm. In *Halla* the unicellular giant fibres are about 8μ–40μ in diameter, and their cell bodies have diameters of 30μ–150μ (Ashworth, 1909; Claparède, 1868). *Arenicola* contains one to three interconnected giant axons, 22μ–43μ in diameter, which are connected to one or two nerve cells (40μ–80μ in diameter) in each segment (Ashworth, 1904;

Gamble and Ashworth, 1898). In the earthworm (*Lumbricus*), where the giant axons may have diameters up to 163μ, five or more cells (the exact number is unknown) join a section of the giant axon in each segment. These cells have diameters of 13μ–24μ (Keyl, 1913). In *Myxicola infundibulum* there are ten or more nerve cells joining the giant axon in each segment. The giant axon in this species has a diameter up to 1.7 mm., and the giant fibre nerve cells have a mean diameter of 25μ (Nicol, 1947, 1948). In a worm having a giant axon 91 mm. long and 740μ in mean diameter and connected with 1300 nerve cells, the giant axon would have a volume of 39,545 x 10^6 μ^3, and the giant fibre cells a volume of 7.9 x 10^6 μ^3, a ratio of 4900:1. This ratio is in sharp contrast to calculations advanced for mammalian neurones. The axon of a rhesus anterior horn motoneurone 25 cm. long and 8μ in diameter, has a volume of 12.5 x 10^6 μ^3; its cell body, 50μ x 50μ x 40μ in diameter, has a volume of 50,000 μ^3, a ratio of 250:1 (Bodian and Mellors, 1945). For a human spinal ganglion neurone, having an axon 1 m. long and 12μ in diameter, and a cell body 120μ in diameter, estimated volumes are 108 x 10^6 μ^3 and 864,000 μ^3, respectively, a ratio of 125: 1 (Heidenhain, 1911). These figures for annelids suggest that morphogenetic factors of undetermined nature are operating to increase the size of the cell body or to multiply the number of cells as the axon enlarges, in order to maintain unaltered the ratio of cell body to axoplasm. Nerve cell volume, theoretically, can be increased by either mechanism, that is by an increase in size of the cell or by an increase in the number of cells; and, in actual fact, it does seem to have occurred by both methods (compare *Halla* and *Myxicola*). It is also possible that it is of some advantage to an animal, like an annelid, that can undergo autotomy and regenerate a region of the body that is lost, to have a multicellular axon that does not suffer degeneration when cut; the principal defence mechanism of the animal would thus remain unimpaired during the period of regeneration.

FUSION OF GIANT AXONS

In many annelids where more than one giant axon is present, it is known that the several axons fuse with one another to form an anastomosing network in the nerve cord. Claparède (1873) was probably the first person to observe such interneuronal fusion among giant axons; he found that the two giant fibres of *Spirographis* (Sabellidae) anastomose with one another in the suboesophageal ganglia and commissures. Friedländer (1888, 1889) subsequently showed that the two lateral giant fibres of *Lumbricus* (Oligochaeta) and *Mastobranchus* (Capitellidae) are connected in each segment by anastomoses. In *Arenicola* (Arenicolidae) the three giant fibres anastomose with one another in each ganglion (Bullock, 1948; Gamble and Ashworth, 1900). In *Neanthes virens* (Nereidae) the intrasegmental axons of two nerve cells fuse together in each segment (Hamaker, 1898); and in the sigalionid *Euthalenessa dendrolepis* two axons arising from nerve cells in the supraoesophageal ganglia unite in the suboesophageal region (Rohde, 1887). Fusion of giant axons has been described also in the Magelonidae and Ampharetidae, and the phenomenon is of common occurrence in several families of oligochaetes. In *Myxicola* (Sabellidae), it has been found that the two giant axons in the supraoesophageal ganglia and oesophageal connectives fuse together in the suboesophageal ganglion to form a single enormous axon, which subdivides and fuses several times in the thorax and in the posterior abdomen. In *Spirographis* and *Sabella* the two giant axons fuse with one another in the suboesophageal ganglia (Claparède, 1873; Thomas, 1940), and in *Sabella*, at least, they are joined together by transverse anastomoses in each of the commissures connecting the two pairs of ganglia in each segment (Nicol, 1947).

Both Hamaker (1898) and Young (1939) have commented on the utility to the animal of these occurrences of interaxonic fusion. In the squid and cuttlefish it ensures that impulses set up on either side of the animal will produce a contraction of the whole mantle and not of just half the sack, as might occur if the two axons were separate. In crustaceans, interaxonic fusion produces a symmetrical contraction of the longitudinal muscles of both sides of each segment as the result of an impulse in any one of the four intersegmental giant axons (Wiersma, 1947). Possibly the segmental motor axons in *Neanthes* (Nereidae) have a similar function with respect to the paired lateral giant fibres. Interaxonic connexions between paired giant axons are probably of considerable significance in the annelids, because in these animals there are no organs specially developed for lateral steering. Alterations in lateral displacement are effected by directing the anterior or posterior part of the body to either side through differential con-

traction of different muscle groups. A giant fibre impulse, in consequence, that stimulated only one half of the body musculature would result in a certain amount of curvature of the body during quick contraction and not in a symmetrical uniaxial shortening of the entire body.

GIANT AXONS OF ANNELIDS AND THE NEURONE THEORY

The discrepancy that exists between the criteria of a neurone, according to the neurone theory, and the occurrence of interneuronal fusion in invertebrate giant axons has been considered by several authors. Instancing the polychaetes, Lewis (1898) and Hamaker (1898) believed that the syncytial giant axons constitute an exception to this rule, as they obviously do if histological criteria alone are employed. Young (1939) has presented a synthesis of these divergent facts for the giant fibres of invertebrates and has pointed out that syncytial giant axons actually strengthen the neurone hypothesis if such axons are regarded as functional entities. In the words of this author: "When axons are fully fused they always work together, impulses set up anywhere in them spreading over the whole continuous neuroplasm"; and again: "In every case where the complete fusion occurs the axons are ones which must always work together during the life of the animal." Impulses within such fused axons, however, are prevented from indefinite spread throughout the remainder of the central nervous system by synapses between them and other neurones. Such a concept obviously has equal validity for the giant axons of the annelids. Impulses set up anywhere in a syncytial giant axon are propagated throughout the rest of that axon (*Myxicola*, *Lumbricus*), and the function of such fused neurones is to effect a unified response in which all the neurones contributing to the fused axon, as well as all the muscles supplied by the resultant syncytial fibre, work together during the life of the animal. As Young (1939) has observed, it is biologically desirable that an impulse in one of these fused axons should spread throughout its extent and is the result to be predicted in such cases on the basis of the neurone theory.

DEVELOPMENT OF THE GIANT AXONS OF ANNELIDS

The development of the giant axons should provide one of the most interesting aspects of this subject. These multicellular axons are such curious structures that a knowledge of their combination during ontogeny is highly desirable. Unfortunately, although the subject has been broached several times, nothing is definitely known of this process yet. On the basis of the definitive structure of the giant axons, however, a few tentative suggestions are offered that may be of value as working hypotheses for investigations of the development of these nerve fibres.

Unicellular giant axons

Ashworth (1909) has presented some interesting facts concerning the development of the unicellular giant axons of *Halla parthenopeia* (Lysaretidae). He found that there is a progressive increase in the number and size of giant axon cells in anterior segments until a maximum is reached in specimens 30 cm.—40 cm. long, after which no further increase occurs. The development of these axons appears to present no features of peculiar neurological interest. It would seem that certain nerve cells in the anterior segments send axons through the nerve cord towards the tail and, as the animal increases in length, the cells and their processes gradually enlarge until maximal size is attained.

Multicellular giant axons

There is practically no information available concerning the development of multicellular giant axons in the Annelida. Vejdovský (1892) stated that the giant fibres of *Rhynchelmis* (Oligochaeta) arise from large cells in the dorsal neuropil of the cord, but since he regarded these cells as neuroglial, and the giant axons themselves as supporting structures, his account is almost incomprehensible. Wilson (1889) merely noted that the giant fibres of the earthworm arise in the dorsal part of the neuropil.

Rohde's description (1887) of a bicellular giant axon in *Euthalenessa* (Sigalionidae) gives the simplest known example of a syncytial intersegmental giant axon in the Annelida and provides a basis for postulating how the other more complex giant fibres in chaetopods could originate. It is probable that the axon of each of the giant fibre cells in the supraoesophageal ganglia grows down the oesophageal connective and fuses with the corresponding fibre from the other side of the body in the suboesophageal region. The fused axon then grows posteriorly through the nerve cord. Young's observations (1939) on the fusion of the two first-order giant cells in the palliovisceral

ganglion of *Loligo* (Cephalopoda) are of some interest in this connexion. In post-embryonic specimens of *Loligo pealii* he found that fusion of the substance of the two axons was still incomplete and that the interaxonic bridge still showed signs of having been formed by the combination of two tubes, indicating its multiple origin. In *Myxicola* (Sabellidae) the arrangement of the giant axons is somewhat similar to that of the bicellular fibre of *Euthalenessa*, except that the two cell processes decussate without axonic fusion in the supraoesophageal ganglia and, in addition, the giant axon is connected with nerve cells throughout its length in the nerve cord (Nicol, 1948). It may be suggested that during the development of this species the giant axon originates as the processes of two cells in the supraoesophageal ganglia and that these processes grow back through the nerve cord. As the axons increase in size, they are brought into apposition by the union of the halves of the nerve cord and fuse together. But at those levels where the cord remains divided into two parts, a single axon remains in each half of the cord and these two axons anastomose with each other in the transverse commissures.

The nerve cells in the nerve cord of *Myxicola* show a segmental arrangement; the peripheral branches of the giant axon also show a segmental pattern, in that they are localized in the anterior and posterior regions of each segment (Nicol, 1948). It may be that intrasegmental motor axons, such as those that occur in the aphroditids and those that synapse with the lateral giants in *Neanthes* (Nereidae), actually anastomose with the giant axon in *Myxicola*. It is suggested that, during growth of the giant axon, processes of these intrasegmental motor neurones enlarge, and one branch joins the giant axon while the other enters a peripheral nerve. It is still more hypothetical to extend this picture of development to other sabellids with a ladder-like nerve cord, since the exact origin of the giant axons in the supraoesophageal ganglia has not been determined. Nevertheless, the arrangement of the giant axons in *Sabella* and *Branchiomma* is very similar to that of *Myxicola*, with the exception that an axon occurs in each half of the nerve cord and, in *Sabella* at least, the axons anastomose in the transverse commissures between the ganglia of the cord.

The giant axon of *Clymene* (Maldanidae) possibly develops in a similar manner. Each axon arises from a large cell in the anterior nerve cord (Lewis, 1898). It is likely that the processes of these two cells grow posteriorly through the nerve cord, fuse with one another and with neurones in each segment, the final structure being a syncytium.

On the basis of an explanation of this nature it is difficult to visualize how the giant fibres of *Nereis* and *Lumbricus* could develop, since these axons are subdivided by transverse septa in each ganglion. It is possible that the transverse septa arise secondarily and divide a continuous axon into short units. There is ample evidence from vertebrate neurology, however, to show that each axon arises as an outgrowth from a nerve cell and that its cytoplasm remains continuous with that of the nerve cell; connexions with other cells are made secondarily by synaptic contact at surfaces. It is more in harmony with these ideas to regard the annelid segmented axons as arising from intrasegmental neurones in each segment, the processes of these cells enlarging and extending longitudinally through each neuromere. At the anterior and posterior borders of each neuromere axons of separate segments would meet and synapse with one another, forming a chain of giant axon units which extends throughout the nerve cord. It is interesting that Vejdovský (1892) claimed that the giant axons of *Rhynchelmis* arise from special cells in each segment and that the separate giant axons then fuse together longitudinally. However, since Vejdovský believed the cells and giant fibres to be neuroglial or supporting structures, his descriptions need to be confirmed by a neurological investigation.

RELATIONSHIP OF THE GIANT AXONS OF DIFFERENT POLYCHAETE GROUPS

It has been suggested that giant axons have arisen independently on several occasions in the Invertebrata, namely, in cestodes, nemertines, annelids, crustacea, and cephalopods, and also in the protochordates and lower chordates (Prosser, 1946). This is a reasonable assumption, since the groups mentioned are so distantly related and the patterns of giant axons are so distinct from one another. Even within the Annelida, however, the giant axons show a great deal of variation, as can be seen from the preceding descriptions, and it is difficult to determine common or intergrading characteristics that would reveal a common origin within the group.

In several families of the annelids the giant axons

are obviously similar within each family. The clearest example of this occurs in the Sabelliformia (Sabellidae and Serpulidae), but characteristic patterns can be discerned also within the Nereidae, Glyceridae, Arenicolidae, Eunicidae, and Sabellariidae. The pattern of giant axons in a number of families of the Oligochaeta appears fairly homogeneous, and it is likely that the giant fibres in this order have a common origin and that the differences represent variations of some basic neuronal arrangement ancestral and common to all groups. It is perhaps noteworthy that the only family of the Oligochaeta in which giant axons are absent is a specialized parasitic one, the Branchiobdellidae (Vejdovský, 1878). In contrast to this picture, it is striking that intersegmental giant axons appear to be absent in a number of free-living polychaete families (Syllidae, Tomopteridae) and are lacking in certain species of families in which they are well developed (Arenicolidae, Capitellidae).

In the face of this variability, it is difficult to establish any homologies until more information is obtained regarding the following problems: (1) the complete extent of the giant axons among the annelids (for example in the Ampharetidae and Glyceridae); (2) the anastomosis and fusion of separate giant axons (for example in *Lumbrineris* and many capitellids); (3) the nerve cells of the axons (for example, in *Eunice*, *Sabellaria*, serpulids); (4) the origin within the supraoesophageal ganglia (for example, of sabellids, serpulids, *Eunice*, glycerids); (5) the occurrence of transverse septa (*Nereis*). The weight of the evidence does suggest that giant nerve fibres have evolved independently on several different occasions in chaetopods, as different groups have become specialized for tubicolous or burrowing habits (compare, for example, the similar burrowing habits and body form of *Lumbricus* and *Arenicola*, and the similar tubicolous habits of *Hyalinoecia* and *Sabella*). On the one hand, these fibres have arisen from enlargement and sometimes fusion of single axons that have grown long distances in the central nervous system; on the other hand, by fusion or synapse of intrasegmental neurones at the boundaries of each neuromere. The Annelida, patently, are a very labile group, no better evidence for which can be found than in the diversity of respiratory mechanisms occurring in the Polychaeta. This diversity clearly is equalled by the heterogeneity of the giant nerve fibres, and further work may well provide a series of very interesting examples of convergent evolution in the central nervous system of this phylum.

AXOPLASM OF THE GIANT NERVE FIBRES

A number of studies have been made of giant fibre axoplasm in the decapod Crustacea and Cephalopoda, but very little information is available regarding it for the Chaetopoda. Friedländer (1888) succeeded in squeezing out axoplasm from the giant fibres of the earthworm, and he believed that they contain a viscous water-soluble substance. The axoplasm of the giant nerve fibre of *Myxicola* is rather viscous and forms a jelly-like strand when squeezed out on a dry cover slip. Moreover, it retains its cylindrical form for about a minute before finally collapsing. The axoplasm is more of a gel than a sol, for although a small amount does escape from a perforation in the axon, flow of axoplasm never proceeds far enough to cause collapse and emptying of the axis cylinder. Since the axon of *Myxicola* alters so greatly in shape during movement of the body, the axoplasm must either be fluid enough to flow and undergo rearrangement during contraction and elongation of the body, or its viscosity must alter continuously during the life of the animal. The giant axons of the cephalopods *Sepia* and *Loligo* furnish an interesting comparison in this regard. Young (1934; 1936c) observed that when the giant axons of these animals are cut, axoplasm flows freely from the cut ends, and that this outflow continues for several minutes, accompanied by a general collapse of the sheath. Flaig (1947) has recently shown that in *Loligo* the viscosity of the axoplasm is not constant, but increases after electrical and possibly after mechanical stimulation. The condition of reversible gelation-solvation proposed for the giant axons of *Loligo* suggests that the high viscosity of the axoplasm of the giant fibre of *Myxicola* is a transient condition. It may well be that viscosity increases as the result of mechanical stimulation during dissection, and may be a concomitant feature of quick contraction in the intact animal. This hypothesis probably could be successfully investigated by using the large axons of various sabellids.

No critical studies have been made of neurofibrillae in the living axons of annelids. A few authors have stated that the giant fibres of these animals contain a homogeneous substance, for example, those of *Arenicola* (Gamble and Ash-

worth, 1898) and *Lumbricus* (Friedländer, 1888). Nevertheless, there are numerous descriptions of neurofibrillae in fixed preparations of the giant fibres, giant fibre cells, and smaller neurones of the earthworm (Boule, 1908, 1909, 1913; Kowalski, 1909; Leydig, 1864a; Cajal, 1904). Among polychaetes, Gamble and Ashworth (1900) and Ashworth (1904) found longitudinal striations in the giant axons of *Arenicola* and a neurofibrillar network in the perikaryon of the giant fibre cells. Similar descriptions have been given of the giant axons of *Halla* (Ashworth, 1909) and of *Lumbrineris* and *Notocirrus* (Fedorow, 1928). Spengel (1881) found fine longitudinal striations in the giant fibres of *Spirographis*, and Cunningham (1887) saw fine lines resembling fibres in the giant axons of *Sabella*. Striations are not visible in fresh axoplasm of *Myxicola*, but fine lines, frequently oriented parallel to the axis and surface of the fibre, occur in fixed and stained sections (Nicol, 1948).

FUNCTION OF THE GIANT AXONS

The several studies made of the dorsal giant axons of the earthworm have shown that these structures are concerned with quick end-to-end contractions that cause the animal to shorten and retract into its burrow after tactile stimulation. Although the three dorsal axons can conduct in both directions, like other nerve fibres (Eccles, Granit, and Young, 1933), despite the presence of macrosynapses, in the intact animal the median giant is fired by tactile stimulation in the anterior region, the two lateral giants by tactile stimulation in the posterior region, and all three fibres by stimulation in an intermediate region of the body (Bullock, 1945a; Rushton, 1946; Stough, 1930). Buddenbrock (1928) has postulated still another function for the dorsal giant fibres. He stated that stimulation of the posterior end leads to peristaltic waves at the anterior end of the worm, and vice versa. Since the impulses responsible for these movements must be carried through the length of the nerve cord, he suggested that the giant fibres are involved in this. Ten Cate (1938) has studied this problem and has stated that after transection of the dorsal giant fibres without injuring the rest of the nerve cord, the quick contraction does not pass the lesion, but the creeping reflex does so. On the other hand, if the dorsal giant fibres are left intact but the rest of the nerve cord is cut across, both the quick contraction and the creeping reflex pass the operated region; that is, stimulation of one end results either in quick contraction or locomotory waves at the other end of the worm, depending on intensity of stimulation. Ten Cate did not describe the histological appearance of his preparations, and it may be argued that the operation of cutting all the small fibres of the nerve cord without interrupting the giant fibres is an impossible one to perform. It is difficult to visualize a nervous mechanism whereby nervous impulses carried by the same nerve fibre, itself having an efferent function, can bring about two quite different responses at different times according to the intensity of the stimulus, as postulated by Buddenbrock and ten Cate. It may be that frequency of impulses in the giant axons is the controlling mechanism. Nothing is known of the function of the ventral giant axons of the Lumbricidae.

Only a beginning has been made in the analysis of the functioning of polychaete giant axons. Bullock (1945b, 1948) has recorded action potentials corresponding to the giant axons from the nerve cord of *Neanthes virens* and has found that each fibre can conduct as a unit in either direction through the nerve cord, independently of the other fibres. Action potentials in all the fibres are evoked by either tactile or electrical stimuli. The median giant is fired by sensory stimulation anteriorly, the small medio-lateral giants by posterior stimulation, and the large lateral giants by stronger stimuli at all levels. The quick shortening reaction of *Nereis* and *Neanthes* is well known (Buddenbrock, 1928; Hamaker, 1898), and Bullock has indicated that the giant axons are concerned in this reaction. Nicol (1947) has cut the giant axon of *Myxicola* without interrupting the rest of the nerve cord, and has found that this operation blocks the passage of quick contractions but not the passage of slower locomotory waves. The evidence shows that the giant nerve fibre of this species conducts the nervous impulses that result in nearly synchronous contraction of all segments. This results in end-to-end shortening and retraction of the feeding crown into the tube. In contrast to the giant fibres of the earthworm, that of *Myxicola* conducts not only in either direction during the natural life of the animal, but can be fired by sensory neurones in any part of the body surface. Nicol, Smyth, and Whitteridge (1947) have made direct recordings of action potentials of the giant axon of *M. infundibulum* and

have found that single fibre action potentials can be picked up from any part of the surface of the animal or from its nerve cord as the result of single electrical or tactile stimuli. An impulse thus originating at any point in this axon is transmitted throughout its extent in the nerve cord as well as in the peripheral nerves, and causes all the longitudinal muscles of the body to contract nearly simultaneously.

Only a limited amount of evidence is available for the functioning of giant axons of other polychaetes. In general, species of sabellids withdraw quickly into their tubes when alarmed. In addition to *Myxicola infundibulum*, this response has been observed in *M. aesthetica*, *Sabella pavonina*, *Spirographis spallanzanii*, *Branchiomma vesiculosum*, *Bispira volutacornis*, *Dasychone bombyx* and *Eudistylia vancouveri*, in the serpulids *Pomatoceros triqueter* and *Protula protula*, and it probably occurs in all species (Claparède, 1870; Hargitt, 1912; St. Joseph, 1894; Soulier, 1891). Since the giant fibres are essentially the same in all sabellids and serpulids, it is reasonable to assume that they form the nervous pathway for this movement. Further investigations may show that in all sabellids and possibly in serpulids as well, the giant axons anastomose with one another and conduct as a unit, and that they are connected with afferent neurones throughout their length. The response is a highly specialized one, well suited to the sedentary mode of existence of these species. All sabellids are tubicolous inactive forms with ciliary methods of feeding. Their tubes are fixed to the substratum or buried in sand or mud; the animals extend their feeding crowns into the water and normally show little movement apart from slow rotation of the crown. They are warned of approaching predators by vibrations, water currents, changes in light intensity, and touch, and these cause the animal to shorten and retract its crown. Other movements are slow peristaltic or antiperistaltic waves of the body musculature. The pattern of behavior, consequently, is very simple in the Sabellidae. It would appear that one part of the central nervous system, the giant fibre system, has become hypertrophied in response to a sedentary mode of existence, perhaps at the expense of other nervous mechanisms concerned with predatory and free-swimming habits.

Since the giant axons of the earthworm mediate startle reactions, it is generally believed that the giant nerve fibres of polychaetes are concerned with similar end-to-end contractions of the worm. Quick shortening movements have been described in a number of species other than sabellids and serpulids, e.g., *Neanthes*, *Arenicola*, *Mastobranchus*, *Diopatra* (Bullock, 1948; Friedlander, 1889). In every species in which quick shortening movements occur, the animal is known to possess well-developed giant axons. It is significant, moreover, that giant axons forming through-conducting pathways are present in many burrowing and tubicolous forms (*Sabellaria*, *Mastobranchus*, *Arenicola*, *Nereis*, *Marphysa*, *Eunice*, *Lumbrineris*, *Clymenella*, *Hyalinoecia*, *Diopatra*). These large axons probably play an important role in the life of the animal in intermediating quick escape mechanisms and, in a recent study, Bullock (1948) has presented some further details of the functional organization of the giant axons of several other polychaetes—non-polarity, areas of effective mechanical stimulation, and "startle" quality of stimuli. For some species it is also possible to make the reverse correlation, namely, that when quick shortening movements are not displayed, giant axons are absent from the nerve cord (*Aphrodita*, *Chaetopterus*, *Amphitrite*, *Cirratulus*; Bullock, 1948). Although the existence of giant axons in the nervous pathway of the giant fibre response of polychaetes now seems to be firmly established, this fact should not preclude examination of the possibility that in some species the giant axons may be concerned with widespread contractions of muscles causing altogether different types of body movements.

GIANT AXON SIZE AND CONDUCTION VELOCITY

The great size of annelid giant nerve fibres suggests that large axon size itself is of considerable survival value and has evolved in response to factors that favor the survival of the individual and the preservation of the species. Pumphrey and Young (1938) have found for the large axons of the stellar nerves of *Loligo* and *Sepia* (Cephalopoda) that conduction is faster in larger axons, and have suggested that conduction velocity varies approximately as the square root of axon diameter. These authors have shown that a significant saving of time is effected by rapid conduction in the large fibres of *Loligo*. Nicol (1948) has extended the same argument to *Myxicola infundibulum*, in comparison with the slow rate of propagation of a nervous impulse in the nerve cord of *Aphrodita*, where giant axons are absent. In a comparison

of this sort it is apparent that the giant axon of *M. infundibulum* has biological value in assisting it is a continuous axon extending throughout the central nervous system, it conducts an impulse

TABLE 1

Conduction speeds in the nerve cords and giant axons of polychaetes and oligochaetes

SPECIES	MAXIMAL CONDUCTION VELOCITY IN NERVE CORD (m./sec.)	SOURCE	GIANT AXON DIAMETER	SOURCE
Aphrodita	0.5	7	Absent	27a, 37, 124
Cirratulus	0.9	7	Absent	27a, 37, 109
Arenicola	1.2	7		
A. cristata	2	27a		
A. grubei & A. marina			13μ–43μ	33, 60, 128
Arabella	1.5	27a	Long distance axons in doubt	27a, 124
Sthenelais fusca	2	7	Present in allied species but size unknown.	124
Polynoë pulchra	2.9	7	Present in allied species but size unknown	124
Pista	4	27a	Large	27a, 99
Clymenella torquata	4	27a	Present	27a, 90
Glycera dibranchiata	4	27a	Large (4 pairs)	27a
G. nigosa	4.3	7		
G. convoluta			16μ–29μ	112, 128
Eunice	4.7	7		
E. rousseaui & *E. harassi*			30μ–130μ	43, 85, 112
Lepidametria commensalis	5	27a	Present	27a
Nephtys	3.5, 5	27a	Small (4? fibres)	27a, 37, 101, 130
Nereis	1.6	7		
Neanthes virens	0.9	7		
	Laterals 6.2	27, 27a		
	Median 5.4			
	Medio-laterals 2.5			
Nereis diversicolor			Laterals 40μ	112
			Median 34μ	
			Medio-laterals 13μ	
Haploscoloplos bustorus	5, 7	27a	20μ (2 fibres)	27a
Lumbrineris	9.4	7	4 fibres, one	27a, 99, 101
	5, 10	27a	very large, 100μ	109, 138
Eudistylia polymorpha (= *Bispira polymorpha*)	6.9	7, 28		
E. vancouveri			30μ–300μ	Original
Diopatra	10	27a	100μ	27a
Myxicola infundibulum	20	114	0.1mm.–1mm.	113
Lumbricus	1.5	21, 22		
	Laterals 10–15	26, 42	Laterals 50μ–60μ	85, 144
	Median 20–45	125	Median 90μ–160μ	
			Myelinated (*L. terrestris*)	

the animal to escape quickly from danger. Not only its size but its structure and arrangement, as well, are conducive to rapid conduction. Since rapidly through all segments, without the synaptic delay involved in interneuronal transmission from one ganglion to another. Since the motor

branches of the giant axon are continuous with it, there is no synaptic delay on the efferent side of the reflex arc either. Finally, since sensory neurones probably are connected with the giant axon in each segment, the amount of conduction time that would be involved in long sensory pathways is reduced to a minimum. The size and structure of the axon are clearly of importance in permitting this animal to retract faster, and the advantage of such giant axons probably has affected the course of their evolution in the other polychaetes in which they occur. It is of interest to note in this connexion that Bullock (1945a) and Rushton (1946) have commented on the fact that in *Lumbricus* the macrosynapses cause little appreciable delay in nervous conduction; thus even when septal interfaces are present, conduction velocity, other things being equal, approximates that of continuous axons. Efferent branches, continuous with the giant axons in the nerve cord, also occur in species other than *Myxicola*, for example, in *Arenicola* (Gamble and Ashworth, 1898) and in *Lepidasthenia* (Haller, 1889), but their occurrence seems to be the exception rather than the rule.

Representative figures are now available for conduction speeds of the giant axons of several annelids. Jenkins and Carlson (1903) have measured rates of nervous conduction in the nerve cords of several polychaetes by a graphical method, and their results are summarized in Table 1, together with some data from other sources. It is probable that Jenkins and Carlson were measuring giant fibre conduction in some of these species. Bovard's figure for *Lumbricus* was obtained by a graphic method; those of Eccles et al., Bullock, Rushton, and Nicol et al. were obtained by measurements of propagation of action potentials. Giant axons occur in all species that have conduction rates of over 1 m./sec. and are particularly large in *Eunice* (rate 4.7 m./sec.), *Bispira* (rate 6.9 m./sec.), *Lumbrineris* (rate 10 m./sec.), *Myxicola* (rate 20 m./sec.) and in *Lumbricus* (rates from 1.5 to 45 m./sec.). In *Cirratulus* and *Aphrodita*, giant axons are absent or very small. These figures serve to emphasize the relationship of giant fibre diameter to conduction velocity in different annelids.

SHEATH AND FUNCTION OF THE GIANT AXON

In some annelids, the giant axons have thickened myelin sheaths in addition to axis cylinders of large diameter. Evidence is now available from other groups that conduction velocity is a function of myelin sheath thickness as well as axis cylinder diameter. This relationship has been suggested by a number of authors who have compared nerve fibres belonging to several different species. Among a group of nerve fibres with different sheath thickness but with axis cylinders of the same diameter, the fibres with the thicker sheaths conduct the faster (Prosser, 1946; Pumphrey and Young, 1938; Schmitt and Bear, 1939). Taylor (1940) has pointed out that earthworm giant axons, compared with fibres of the frog, reveal that conduction speed varies both with sheath thickness and fibre diameter, and recently Sanders and Whiteridge (1946) have been able to substantiate this conclusion by utilizing the alteration in axis cylinder diameter and myelin sheath thickness that occurs during nerve regeneration in mammals.

Myelinated giant axons appear to have arisen on several occasions, in polychaetes, oligochaetes, decapod crustacea, and chordates, and their sporadic occurrence in species of several different polychaete families suggests that they have evolved independently in a number of species of this order, namely, in the Spionidae, Maldanidae, and Capitellidae (Friedländer, 1889; Langerhans, 1880; Lewis, 1898). Of the two mechanisms available for increasing conduction velocity, increase in axon diameter and increase in myelin sheath thickness, it appears that in most species of polychaetes evolution has led to enlargement of the axis cylinder; but that in a few species of polychaetes and in lumbricids, evolution has progressed along the alternative path towards increased myelination.

SUMMARY

1. Since their discovery by Claparède in the Oligochaeta in 1861, giant nerve fibres have been found in nearly all families of oligochaetes, and in the following polychaete families: Aphroditidae, Polynoidae, Sigalionidae, Nereidae, Nephtyidae, Glyceridae, Eunicidae, Lumbrineridae, Onuphidae, Lysaretidae, Orbiniidae, Spionidae, Magelonidae, Disomidae, Cirratulidae, Opheliidae, Capitellidae, Arenicolidae, Maldanidae, Fabelligeridae, Sabellariidae, Ampharetidae, Terebellidae, Sabellidae, and Serpulidae.

2. The significance of these large axons was in doubt for half a century. Their nervous nature was proved gradually by histological investigations

which showed that they arise from nerve cells and that they branch, and from studies which revealed changes in behavior after cutting these fibres.

3. In the earthworm three large dorsal fibres are present. These axons extend throughout the nerve cord but are divided into longitudinal units by septa in each segment. They are syncytial structures, since they receive the processes of several nerve cells in each segment, and they have well developed myelin sheaths. One to three giant axons occur in other families of oligochaetes.

4. Several quite distinct patterns of giant axons are present in polychaetes. They may be intrasegmental and enter the peripheral nerves (Aphroditidae, Polynoidae, Sigalionidae, Ichthyotomidae); or they may be intersegmental and extend through many neuromeres (Polynoidae, Sigalionidae, Eunicidae, Lysaretidae, Onuphidae, Arenicolidae, Nereidae, Maldanidae, Capitellidae, Sabellariidae, Sabellidae, Serpulidae, and others). Both unicellular and multicellular giant axons occur in polychaetes. Unicellular giant axons are present in species of Sigalionidae and Lysaretidae; syncytial giant axons are probably more frequent and occur in species of Arenicolidae, Maldanidae, Capitellidae, and Sabellidae. Where the axons possess definite structural polarity, with their nerve cells restricted to particular regions of the central nervous system, they form groups of fibres running from the anterior region of the nerve cord towards the tail, or in a reverse direction, or both (*Euthalenessa* and *Sigalion* in the Sigalionidae; *Halla* and *Aglaurides* in the Lysaretidae). Intersegmental septa have been described in only one species of polychaete (*Nereis*), and it is probable that the majority of polychaete giant axons are continuous structures.

5. Annelid giant axons vary in size from about 10μ in *Nephtys* to 1.7 mm. in *Myxicola infundibulum*. In the earthworm, the median axon may reach 160μ in diameter, and the lateral axons are about half as large. They are particularly large in burrowing or tubicolous polychaetes (*Hyalinoecia*, *Eunice*, *Arenicola*, *Lumbrineris*, sabellids in general). In any one uniform group, like the Sabellidae, the fibres vary in dimensions with the size of the species, the size of the individual, and the state of extension. They also show progressive alterations in diameter along their length and, occasionally, regularly occurring variations in diameter in the form of constrictions.

6. Giant axons are surrounded by sheaths of supporting cells and fibres. The sheaths are myelinated in some lumbricids, spionids, capitellids, and maldanids. Myelination appears to be absent or weakly developed in sabellids, lysaretids, arenicolids, and nereids.

7. Very little is known of the development of annelid giant axons. It is suggested that multicellular giant axons which begin in one or several nerve cells in the supraoesophageal ganglia or anterior nerve cord develop as processes of these cells, and that intrasegmental giant neurones establish connections with these advancing axons secondarily. Where the giant axons are divided into segmental units, it is more probable that they develop from the apposition of hypertrophied intrasegmental neurones at the boundaries of each metamere.

8. More evidence is needed before firm conclusions can be formulated about the homologies and evolution of giant axons in the Annelida. The diversity of structure and arrangement found in the giant axons of chaetopods, however, indicates that they have arisen independently in the Oligochaeta and in different families of the Polychaeta, as different groups have become specialized for tubicolous and burrowing habits.

9. From experiments in which the giant axons have been cut and from electrical recordings of action potentials, it has been established that the giant axons of *Lumbricus* conduct nervous impulses resulting in quick contractions of the entire body. The three axons of this animal conduct in either direction as the result of tactile and electrical stimulation but, owing to differences in sensory connexions, the median giant conducts predominantly posteriorly and the lateral giants conduct predominantly anteriorly.

10. The giant axons of many polychaetes probably have a function similar to those of the earthworm, and conduct impulses leading to quick contraction and retraction from danger. This has been established for *Myxicola infundibulum* by cutting the giant axon and by recordings of action potentials. In *Myxicola* the giant axon conducts anteriorly and posteriorly as the result of natural stimulation and is connected with sensory neurones throughout its length. In *Neanthes* one of the giant axons is connected with afferent neurones throughout its extent, while the others have more spatially restricted sensory connexions. Species of *Arenicola*, *Mastobranchus*, *Diopatra*

Clymenella, of the Nereidae, and the Sabellidae are capable of quick retreat by widespread contraction of longitudinal muscles, and in these forms at least the giant axons very likely are concerned in intermediating this startle reaction.

11. Giant axons have considerable biological value to a species by saving conduction time, and thereby permitting the animal to retreat faster. Factors which reduce the time interval between stimulation and onset of movment are: large axon diameter, with concomitant increase in conduction velocity; continuous conducting path throughout the nerve cord; short afferent pathways between the body wall and the giant axon; in some species, continuous efferent pathways between the giant axon and the longitudinal musculature of the body wall in each segment.

12. Measured conduction velocities of annelid giant axons vary from about 2 m. per sec. in *Arenicola* and 6 m. per sec. in *Nereis* to 45 m. per sec. in *Lumbricus*. In general, conduction velocity is greater in myelinated than in unmyelinated fibres of the same axis cylinder diameter. Increase in conduction velocity seems to have been effected independently in the different groups of oligochaetes and polychaetes, either by increase in fibre diameter or by increase in myelin sheath thickness.

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THE PRINCIPLE OF STABILITY AS A CAUSE OF EVOLUTION
A REVIEW OF SOME THEORIES

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AMID the luxuriant crop of rival theories which sprang up after the publication of Darwin's views on the origin of species, a large proportion falls under the general heading of orthogenesis, a term denoting evolution along definitely directed lines, but agreeing in little else except that the direction of these lines is *not* caused by natural selection. Vitually all of the proponents of orthogenesis stress the importance of ascertaining the causes of variation, and contend that Darwin's theory is inadequate because of its failure to give a reasonable solution of this problem. In general, the orthogenesists are largely hostile to Darwin's conception that variations are largely "fortuitous," and they would substitute some more sober and law-abiding kind of variability for the random "chance" happenings with which Darwin believed his theory could get along.

As to what these uniformly acting causes are, we find the greatest variety of assumptions. They range from divine guidance and teleological control to purely mechanical explanations. Lamarckian heredity, with the various hypotheses as to how it can be accounted for, figures prominently in theories of directed variability, and in several cases it is associated with an appeal to a teleological factor or some other principle not clearly defined. It is not my intention to review the varied theories of orthogenesis. Out of the great diversity of speculative endeavors, many of which have little interest in the light of present-day knowledge, I confine myself to a single fairly well defined class based on the so-called principle of stability which most of its upholders have derived from the law of entropy, or the second law of thermodynamics.

The principle of stability as a factor in evolution was elaborated by G. T. Fechner in a brochure entitled *Einige Ideen zur Schöpfungs- und Entwicklungsgeschichte der Organismen*, published in 1873. Fechner endeavored to show that throughout nature there is a marked tendency for material to form bodies of varying degrees of stability, a tendency which he regarded as closely related in its action to the conservation of energy. Theoretically, he stated, there may be absolute stability or absolute instability, but both of these conditions are never completely realized. A body at rest represents a limiting condition which, in the absence of disturbing outer forces, may persist indefinitely. There may also be aggregates whose parts undergo continual movements that bring about the recurrence of a given state in regular cycles, as may be illustrated by the solar system. It is assumed that if any group of moving bodies were limited to a space into which and from which no energy or material could pass, the movements of these bodies would in time settle down into a regular series of recurring changes. In a state of nature, bodies, according to Fechner, *tend* to form stable groups of this kind, but they encounter so many disturbing influences that only under certain conditions, as in the movements of the heavenly bodies, does this tendency become manifest. On the earth it comes to expression more or less conspicuously in the realm of organic life. Life processes typically run through a series of changes that repeat themselves generation after generation, and within the individual organism there may be various rhythms, like the beating of the heart, which are subordinate to the larger rhythms of the life cycle. A living being represents a kind of dynamic equilibrium which responds to changes from without by modifications that preserve the life of the whole. Fechner has contended that the more complex types are the more stable ones and that hence life tends to manifest itself in more and more highly organized forms.

Fechner proposed his theory as supplementary to the theory of Darwin. He acknowledged the important function of natural selection in the progressive development of life, but he held that Dar-

win's theory, by itself alone, is incapable of giving a satisfactory explanation of the process. He regarded his principle of stability as of more fundamental import than the theory of natural selection. Unfortunately, Fechner's exposition of it was associated with a number of speculations which doubtless contributed to its belated recognition. The idea that inorganic molecules came originally from living organic molecules, instead of the reverse; the theory that species and even most varieties represent the culmination of independent lines of descent, instead of the terminal twigs of a branching genealogical tree; and the notion that the whole evolution of life occurs as a kind of unit, in which the mutual relationships of living beings result from preformed relations occurring in the primitive organic molecules from which all life, as well as the inorganic world, took its origin; to say nothing of other speculations still more at variance with the prevailing conceptions of biologists in general,—these certainly lent no support to Fechner's evolutionary standpoint.

The formulation of the stability principle was not entirely original with Fechner. Its essential components had been clearly and much more logically set forth by Herbert Spencer in his *First Principles* in 1862. In many, if not in most, respects the ideologies of Fechner and Spencer were widely divergent, but they have a few basic similarities in common. Spencer endeavored to give a deductive derivation of his law of evolution. In his conception, the fundamental factor of "the persistence of force" leads to certain derivative general principles, viz., the multiplication of effects, the instability of the homogeneous, segregation, differentiation, and equilibration, which, taken together, give rise to the process of evolution as a resultant effect. Little is said in *First Principles* about natural selection, except as a kind of secondary agency to which, at times, Spencer was glad to be able to appeal. His basal concept of evolution took its form independently of Darwin, and in large measure before Darwin's *Origin of Species* appeared. As in Fechner's later theory, Spencer held that an essential role in the process of evolution is played by the "instability of the homogeneous," and hence by implication, by the stability of the heterogeneous. This principle was supposed to apply in all phases of the evolutionary process, from the genesis of planetary systems out of nebulae to the evolution of human societies. Spencer supported his law with a large amount of inductive evidence drawn from a variety of fields. His attempt to derive it from first principles constituted a striking difference between his treatment of evolution and that of Charles Darwin. In Darwin's writings there is no intimation that evolution simply had to come about as a result of antecedent principles. Darwin was convinced that evolution must have occurred, simply because the facts of observation pointed in that direction. And the direction of evolution was not regarded as inevitably toward greater complexity—it might be forward, backward, or sidewise, as conditions determine.

Both Spencer and Fechner invoked the principle of stability in their idea of the instability of the homogeneous and the consequent tendency of organisms to become more complex as a result of general laws which obtain in the physical world. Spencer's critics have urged that it is by no means general that the heterogeneous is more stable than the homogeneous. Under certain circumstances this may be true; under other conditions, the reverse is true. Spencer indeed realized this fact, but he regarded progress toward an increasing heterogeneity as a predetermined tendency deducible from the persistence of force. Yet such progress could hardly go on forever. Eventually its increasing complexity generates its own nemesis, and a stage of dissolution follows. Periods of evolution and dissolution throughout large parts of the universe were conceived to follow each other in a perpetual rhythm, both processes being the inevitable consequence of the persistence of force.

Fechner made no reference to Spencer, owing perhaps to his impaired eyesight which, as he explained, prevented him from reviewing the extensive literature on evolution and from making references to the work of other authors. He also made no mention of the second law of thermodynamics, but his stability principle, according to Petzoldt and Jensen, who have attempted to develop it further, is a logical consequence of that law. Whether or not such a conclusion follows, it is evident that he regarded his principle as a fundamental law of causation. Fechner was a strict parallelist. He also espoused the cause of teleology and mechanism at the same time. Speaking of the relation of the teleological principle to uniform causality, he remarked: "Since the tendency to stability in the sense of a causal principle is realized through the uniform influence of forces, this fact affords the ground for the often overlooked

harmony of both principles in the physical realm since they differ because, in the causal principle, one is concerned with the ground, and in the teleological principle with the end of one and the same uniform process."

Concerning the relation of stability to purposiveness, Fechner stated that "In fact, when we consider the matter closely, we designate the structures and outer conditions of an organism as adaptive only so far as they lead to an approximately stable state and enable it to maintain itself with more or less modification; for the death of an organism in its material aspect results from the loss of stability. Hence the principle of the tendency to stability coincides with the teleological principle so far as this relates to the material side of the organic world." Fechner, therefore, was persuaded that it was quite possible for him to conceive of evolution as determined by physical principles and at the same time as governed by ends.

Spencer, like Fechner, made no mention of the second law of thermodynamics, because, in his case, the law had not been formulated when he wrote his *First Principles*. Since, however, he spoke of "the integration of matter and the concomitant dissipation of motion" as essential features of his general law of evolution, it is evident that his standpoint has much in common with that of the upholders of the stability principle, although, so far as I am aware, none of them has mentioned him in this connection.

Most of the upholders of the stability principle, whether they have based it specifically on the law of entropy or not, seem to have labored under the impression that they were advancing an entirely original view. To an unusual degree their theoretical formulations, with few exceptions, have at least the appearance of independent efforts. Fechner (1873), as before stated, made no reference to Spencer. Nägeli (1884), in his discussion of entropy, referred neither to Spencer nor Fechner: Le Dantec (1910, 1913) did not refer to Spencer, Fechner, or Nägeli; Petzoldt (1894) considered only Fechner in his discussion of stability; and Blum (1935) has made no mention of any of the preceding names. All of these writers have attributed evolution largely to physical causes which make for stability in both the living and the non-living world.

In support of this generalization, which has made a strong appeal on account of its all-inclusiveness and the possibility of deducing it from basic physical laws, one may readily point to the tendency of material throughout the universe to form more or less stable aggregates, both static and dynamic. Atoms, instead of being indivisible as their name implies, are found to be groups of various units clustered in the nucleus and surrounded by electrons buzzing around at tremendous speed. Ordinarily stable in their composition, atoms may lose or reacquire one or more of outer electrons, and under the influence of very powerful agencies they may be broken asunder or subjected to other changes in their composition. The number of ways in which the components of atoms can be united to form more or less stable bodies is apparently strictly limited. Disregarding isotopes, the ninety-odd kinds of atoms which are known and which fit into their definite places in the periodic table may be looked upon as resulting from the possibilities of combination determined by the properties of their constituent units. Fechner, were he acquainted with the findings of modern physics, would doubtless have derived much satisfaction in applying his "principle of the tendency to stability" to the atomic world.

Similarly, the different ways in which atoms can be combined to form more or less stable molecules may be regarded as limited by the properties of their component atoms. Aside from the compounds containing carbon, which may be loosely described as almost infinite, the number of possible combinations of most elements is not very great. Some elements form very few compounds, and a few of them, such as helium and argon, even none. Chemists have made much progress in explaining these striking differences in terms of atomic structure. The periodic law, at first an empirical generalization, has been given a rational interpretation in the same way. In the light of knowledge of atomic structure, chemists are now able to predict certain properties of compounds in advance of their formation, so that these properties no longer need to be looked upon as mysterious emergents.

Neither among atoms nor molecules are there any bodies which are absolutely stable. Were Fechner alive today he could look upon everything in the universe as in a Heraclitian flux in which there is a widespread tendency to form more or less stable bodies. On the average, this tendency is favored by the dissipation of energy in the form of heat. And this fact, of itself, often gives rise to a kind of evolutionary process. The relatively

stable, moving equilibrium of the solar system has long been cited as an illustration of an evolution produced in this way. The movement of molecules at low temperatures to form crystals, and the aggregation of crystals into the beautiful six-sided snowflakes or frost patterns that simulate the forms of plants upon windowpanes in winter, are processes that exhibit formative activities which are dependent upon an increase of entropy. The conditions for the formation of stable bodies, however, vary greatly with different materials. Many substances require a fairly high temperature for their production, and in general whether a given compound is stable or not depends upon surrounding conditions. Ordinarily, hydrogen and carbon monoxide are fairly stable gases. Under proper conditions of heat and pressure, in the presence of metallic catalysts of simple chemical composition, these gases may unite to form various alcohols, ketones, and other organic compounds which vary with the degree of temperature and pressure and the nature of the catalysts employed. A special environment like that supplied by the tissues of a living organism doubtless affords the conditions in which certain very complex proteins are able to maintain a fairly stable composition. Within the bodies of organisms the union of micelles to form fibers, lattices, and colloidal configurations carries further essentially the same kind of a process and may be looked upon as playing an important role in building up many types of intracellular structure.

Thus the fact of the tendency to form stable bodies, exhibited in both the living and the non-living, affords one of the chief supports of the theory which would interpret the whole course of evolution as flowing inevitably from the tendency toward increased stability. In applying this principle in the biological realm, Fechner was led to look upon the whole evolution of organic life as predetermined by the properties of his original organic molecules; and he also assumed that the different species of plants and animals are the products of independent lines of descent which trace back to the ultimate living units. It is noteworthy that Carl Nägeli, the chief proponent of orthogenesis from internal causes, was among the few biologists who have advocated a similar view (1884). Nägeli attributed evolution chiefly to a Vervollkomnungsprinzip (commonly translated "perfection principle"), by which species are produced with a minimum of branching, along separate lines which originated at different times by spontaneous generation. He strongly repudiated the idea that this principle is vitalistic; on the contrary, he contended that it operates in a purely mechanical fashion. He attributed the driving force of evolution to the law of entropy. "In general," Nägeli remarked, "the tendency toward a definite modification is based upon the second law of thermodynamics, or the law of entropy of Clausius." Our whole world transforms unceasingly toward a maximum of entropy and "the law of entropy gives a specific direction to phylogenetic development." Through its action it was held to give rise to a hierarchy of objects of increasing complexity from atoms, molecules, and micelles up to a complex network of idioplasmic strands. The forces involved in inorganic evolution thus inevitably lead on to the production of living matter, which continues the same trend and gives rise to definitely directed lines of evolution in the living world.

Those who attribute the chief impetus of evolutionary advance to internal causes, whether these arise from the law of entropy or some other factor, are prone to relegate natural selection to the minor and negative role of merely eliminating the unfit. But with evolution from internal causes taking much the same course whether selection occurs or not, as Nägeli and Fechner contended, the origin of adaptation becomes a serious difficulty. Fechner's attempt to grapple with such problems as those presented by the mutual adaptations of flowers and insects led him to adopt a very fanciful assumption. Holding the view that different species are produced by internal factors along lines whose direction is determined by the constitution of the organic molecules from which they originated, he postulated that all forms of life were related in their evolution, much as the parts of an organism are integrated in the course of their development. They are all parts of the earth, which he looked upon as one great inclusive organism. Fechner was not often dismayed by the logical consequences of his speculations even if they led him to adopt some mystical standpoint, as is shown in a number of his other theoretical adventures.

Nägeli also encountered difficulties with the problem of adaptation, on account of his assumption of independent lines of evolution determined by his Vervollkomnungsprinzip; and his method of dealing with it, while less fantastic than that of Fech-

ner, caused him to have recourse to highly questionable assumptions. In the first place, he was led to minimize the extent of adaptive modification by limiting it to small changes effected by the organism's own power of making appropriate direct reactions to surrounding conditions. And he also assumed that these changes, if long continued, can impress the idioplasm and be transmitted to the progeny. Speaking of the device by which the flowers of *Primula* secure cross-fertilization by having the anthers and stigma at different heights, he assumes that these organs were situated originally at the same level and that "the beginning aversion to self-fertilization effects in the idioplasmic strands which are determinative of spatial arrangement, a separation into two primordia, and, in consequence of the virtual repulsion, a separation of these primordia from each other, or at least a separation of the unfolding organs." This smacks of Lamarckism, and that, moreover, in one of its most questionable features in attributing adaptive modification to the direct effect of an organism's needs.

In minimizing the extent of adaptive changes in organisms and in attributing what little there is to very improbable causes, Nägeli rendered his position very vulnerable to the trenchant criticisms which Weismann urged against it. Adaptive modifications, as Weismann pointed out, are often very far-reaching, as is well illustrated in the extensive transformation required to convert a terrestrial mammal into a whalebone whale. The same fact is shown by the numerous parasites such as *Sacculina* which have undergone very extensive modification fitting them to live upon or within a particular host. On every hand we find organisms which have obviously undergone profound changes in relation to other organisms. In fact, the whole picture of the world of life is such as to indicate that the forces which have guided the course of its evolution have ever operated in an opportunist fashion.

In his treatise on *Organische Zweckmässigkeit*, Jensen applied the stability principle in the effort to throw light upon the causes of evolution and embryonic development. He rejected Lamarckism and strongly opposed all appeals to non-mechanistic factors, but, while conceding great importance to natural selection, he hailed the stability principle as affording a welcome deliverance from many serious difficulties for which he considered Darwin's theory to offer no adequate solution. Like Nägeli and Petzoldt, he ascribed the major causes of evolutionary change to the second law of thermodynamics as a means of explaining the increasing complexity of life, both adaptive and non-adaptive. Even injurious characteristics, according to Jensen, fall under his theoretical explanation equally well. Variation from inner causes was admitted to result in many relatively unstable forms that fall by the wayside. As a result of this elimination, which has gone on ever since the beginnings of life, the "evolving living systems continually keep in the closest accord with the factors of the environment, so that nothing but adaptation can result, ... we cannot expect it to be otherwise, therefore, than that the present variability of organisms thus derived keeps in general within the limits of adaptive capacity or the possibility of stable maintenance." Granting that there has long operated a tendency to progressive variability (fortschreitende Variabilität), it is evident that all but a small proportion of departures from type are still bad from the standpoint of survival. Whether such a progressive tendency would be expected to follow from the law of entropy will be discussed briefly further on.

The most elaborate application of the concept of stability to evolutionary theory was made by Le Dantec in his *La Stabilité de la Vie* (1910). His treatment throughout was deductive. Having defined life as essentially assimilation, under which term he would subsume habit formation (assimilation functionelle), he stated that "by a logical series of deductions from the basic notion of assimilation characteristic of life, one is able to infer the necessity of the transmission of acquired characters. In taking as a point of departure, in addition to the fundamental notion of assimilation, other notions almost equally general ... one can establish by a series of deductions which recall the sequence of theorems in geometry, the necessity of other laws governing directly all the particular facts of the natural sciences."

In order to afford a foundation for his biological deductions, Le Dantec devoted a good part of his volume to the physical principles from which the tendency to stability is derived. Organic evolution he regarded as an expression of the "law of progressive stability." Any variation that adds to the stability of the organism renders it more apt to survive. Le Dantec did not hold that the more stable variation necessarily produces a more complex organism. A degenerate parasite may

have more stability than its more highly organized progenitor. Since evolution is always in the direction of greater stability, whatever direction it takes, variation becomes more and more restricted as evolution proceeds. Hence a certain rigidity, analogous to senescence, tends to settle down upon the world of life and causes its evolution to slow down as it leads to the production of more stable forms. A similar tendency for variation to become more restricted in the course of evolution has been postulated by a number of orthogenestists who have attributed evolution to internal causes.

Le Dantec, although a confirmed Lamarckian, was less hostile to the theory of natural selection than most proponents of orthogenesis. Perhaps this was because he could so readily construe natural selection as the persistence of the more stable variations. Lamarckism and Darwin's selection theory he regarded as not so much opposed as complementary, the one giving a rational explanation of the causes of variation, the other accounting for the accumulation of those variations which are best adapted to the conditions of life. But the great merit of the Lamarckian view, in Le Dantec's opinion, is that variations result from the ability of the organism to adjust itself directly to environmental changes. Organisms form useful habits, a process which he called functional assimilation, and which he regarded as a basic property of life as he defined it. Hence he concluded that we may "state in advance as a necessary conclusion from the definition of life that the hereditary patrimony of a species which would vary in the Lamarckian fashion would become more stable by the very fact of its having varied. This is the statement of the law of progressive stability of living species." Once in possession of this "law" deduced from the proper definition of life, Le Dantec was persuaded that the solution of many biological problems becomes very much easier.

This law of progressive stability, according to Le Dantec, has a purely physico-chemical basis. When one variation is substituted for another in the course of the life process, "one finds the biological equivalent of the thermo-chemical principle of Berthelot: Of two possible reactions, that which is produced is that which releases the greatest amount of heat, the heat being a necessary condition of the phenomena; of two vital phenomena which are equally possible, that which is produced is the one which releases the most vital energy, and which consequently, fulfills most perfectly the conditions of continuing phenomena."

Le Dantec claimed that the principle which he had deduced "makes it possible to derive from Darwin's natural selection not a truth *a posteriori*, as the English naturalist has done, but an *a priori* truth, a general law applicable of necessity to everything that lives." This a priori law was held to apply widely in the non-living world as well, as he attempted to show in a subsequent volume, *La Lutte Universelle*. Having supplied a deductive basis from which natural selection as well as the Lamarckian factor may be derived a priori, Le Dantec was able to declare that "the notion of natural selection thus receives an importance far surpassing the limits of biology."

Another attempt to apply the principle of entropy in the interpretation of evolution has been made by Harold Blum (1935), who is convinced that the reason why biologists in general have failed to adopt the theory of othogenesis "has been the failure, thus far to demonstrate the existence of the necessary directing factor outside of theological doctrine." Blum, one may infer, is not a Lamarckian; he is convinced that natural selection is of great evolutionary importance in eliminating non-adaptive variations, but since he conceives that Darwin's theory presupposes the occurrence of chance mutations in all directions, he holds that it does not adequately account for the tendency of evolution to follow definitely directed lines. This tendency, he believes, "would seem to be afforded by the second law of thermodynamics." Hence "the series of mutational steps, A→B→C, is alone possible and that the reverse order of occurrence is impossible, or at least much less probable." However, mutations do sometimes occur from B→A; while to conclude that because the direction of variation is more frequently from A→B, it must be due to the law of entropy, is a very hazardous inference. If the variation B, for instance, is caused by the loss of a chromosome, or even a small deletion, one would not expect that B could give rise to A. But if we consider only mutations in single genes, the probability of return mutations would depend on the mechanisms involved in mutational changes. It is now rather clearly established that so-called gene mutations are frequently correlated with chromosome breaks at or near the loci to which the mutant genes have been assigned, followed by the joining of the

broken end with a locus from a different chromosome or a different part of the same chromosome. This produces the so-called position effect, which is brought about as a sort of mechanical consequence of breaking and rejoining. From this viewpoint a return mutation would involve a break not only in the same situation as before, but also a break elsewhere at a particular locus which would enable the original parts to be brought together in their previous relation. From the nature of the case this would be a relatively improbable event. It is evident, I think, that the attempt to apply the second law of thermodynamics to cases like this can hardly be fruitful.

It may be claimed that many gene mutations are caused by chemical changes in discrete genes instead of position effects which result from rearrangements. But granting that such changes occur, which seem probable a priori, we still do not know whether they are more likely to occur in any one direction than in the opposite one. There are certain directional tendencies observable in mutation. Some mutations are much more prone to appear than others. An albino, whether due to a loss mutation or not, does not produce a black animal, but a black animal may produce an albino. The directions followed by variation, while obviously very numerous, are not unlimited. This would seem to follow whether mutations are due to position effects, to chemical changes in individual genes, or to the varied combinations of characters observed in Mendelian segregation. Theoretically the law of entropy can find a reasonable field of application only in the second of these possibilities. However, this law is an expression of the fact that changes involving a transfer of energy result *on the average* in an increase of entropy. Many reactions, as Blum has stated, lead, as in the familiar phenomena of photosynthesis, to the reverse effect, that of building up compounds of greater available energy than their original components. Such reactions are common in the synthetic processes of living organisms, even though the net effect of all their activities is to increase the entropy of the universe. Just what kind of a reaction from the standpoint of thermodynamics is concerned with the production of a gene mutation it would be hazardous to assume.

Much remains to be learned concerning the causes of mutations. So far as these causes have thus far been revealed, they have been found to be some kind of external influence. Whether the germinal mutations that arise are associated with an increase or decrease of entropy we simply do not know; and we are hardly in a position to judge of the probabilities. Whether or not variation tends to follow definitely directed lines as a result of internal causes is a question upon which biologists are far from being agreed. Many evolutionists, especially among the paleontologists, have been strongly convinced of the existence of such a tendency, whatever opinion they hold regarding the efficacy of natural selection. In the group of biologists who are persuaded that they have found such a tendency in the principle of stability based on the law of entropy one possibly should include L. S. Berg, who has amassed a striking collection of facts indicative of orthogenic trends. Although a Lamarckian and a teleologist, Berg has remarked in the few words he accorded to the subject of entropy that "according to the doctrine of contemporary physics, all the processes which occur in the inorganic world have a determined direction; or, expressed differently, that the entropy of the universe tends toward a maximum... The principles of stability and development contain elements of teleology, says Wundt (ii, p. 66). From the foregoing it is clear that our view radically differs from the position of the Darwinians who maintain that variability, upon which natural selection operates, has no determined direction." Unfortunately, so far as I am aware, Berg has made no more explicit statements of his position on this topic.

Muller, in discussing the production of mutations by x-rays, remarks that "in ordinary substances, they are known to produce chemical changes of all kinds—not simply 'break-down' processes. However, the 'break-downs' may occur oftener, as is true in general, in harmony with the second law of thermodynamics." This remark, which was not elaborated further, apparently led R. L. Berg to associate Muller and Blum in the general statement that "from the point of view of these authors the evolution of mutability takes place in accordance with the second law of thermodynamics quite independently of natural selection. In the course of accumulation of entropy, mutations become more and more rare and the quantity of energy transformed also decreases. In other words the mutation process is gradually dampened. This view, however, seems to me to be erroneous." Berg then proceeds to describe her experiments, which she interprets as showing that mutation rates may be determined by natural

selection. As to the correctness of this conclusion, I express no opinion. The relation of the principle of entropy to the factors controlling the direction and the frequency of mutations is at present a highly speculative problem which presents many possibilities of interpretation. One cannot safely argue from a phenotypic change to the nature of the mutation concerned in its production. For all that we know, even a mutation leading to the loss of a character may be due to an increase of complexity in a genetic factor and a decrease of entropy—and vice versa.

Most of the proponents of the stability principle look upon evolutionary changes as due chiefly to the very slow action of internal causes, and they are disposed to regard abrupt mutations, whether large or small, as having a relatively minor influence on the general direction of evolution. Blum is an exception to this rule, in that he apparently looks upon evolution as effected through the accumulation of mutations. He has not discussed the stability principle as such, although he has attributed evolution to the same fundamental cause as the upholders of that theory. His position seems to be more closely related to that of Jensen than to those of the other advocates of the principle of stability.

The law of entropy is, of course, manifested in the various activities that constitute life. Does it constitute the basic factor leading to the increasing complexity of living organisms? Stability is a very inclusive category, applicable to governments as well as to physical objects. A stable entity is one that endures. Hence the survival of the fittest may be construed as the survival of the more stable forms, and consequently natural selection may be regarded as among the many manifestations of the principle of stability, as claimed by a number of the proponents of this doctrine. But in considering this very simple disposition of the problem, we should bear in mind that stability may be brought about in very different ways. The stability of an ecclesiastical institution can hardly be explained as one might account for the enduring properties of a quartz crystal. The relatively stable temperature of a mammal or a bird requires the cooperation of very different functions, carried on in remotely situated organs and in response to many different kinds of stimuli. The stable running of a watch is doubtless in accord with the principle of entropy, after potential energy has been put into its mainspring when it is wound up. Much of the activity of an organism occurs in an analogous way because energy has been put into its foodstuffs in the process of photosynthesis. The sun is the great winder of the organic watches, which also keep time in their imperfect way in their cyclical changes.

The second law of thermodynamics is a statistical generalization, and there is much evidence that events which are of essential importance for the maintenance of life result from the back eddies in the predominantly downward course of the stream of energy. Many kinds of construction involve the dissipation of energy, as in the formation of a snowflake; others nevertheless occur with the absorption of free energy, as in photosynthesis and the formation of many organic substances through the energy supplied by the breaking down of other compounds. The stability of any composite body depends upon the conditions immediately surrounding it. The mere dissipation of thermal energy affords the condition which permits other forces to give rise to many kinds of stable, and at times very complex, structures. If we may properly use the stability principle to designate the forces instrumental in the formation of molecules and crystals, in so far as they rest on a common basis, we can safely apply it to organisms only to the extent that their integrative activities result from the same physical causes. Analyses of these activities, such as those described in Cannon's illustrations of homeostasis (1939), show that the maintenance of constant states depends upon procedures quite different from those concerned with the formation of a molecule or a crystal. This fact does not imply that these varied physiological activities may not ultimately be resolved into physical and chemical components. It does mean that the maintenance of the stability of an organism is too much like preserving the stability of a government to be accounted for by the law of entropy.

Outside of the group of theorists discussed above, most of the orthogenesists who are not Lamarckians have been quite at sea. Weismann's attempt to explain definitely directed variability by his hypothesis of germinal selection has proved to be quite inconsistent with what is known of the mechanisms of hereditary transmission, and it probably has no defenders at the present time. Many, if not most, orthogenesists make no attempt to explain the causes of directed variability. A number

of orthogenetic trends among forms which show a gradual increase in size in successive generations have been very plausibly interpreted in accordance with the principles of relative growth, which have been ably elaborated by Julian Huxley. Here the primary factors in orthogenetic change are those concerned with the increase in size. As a matter of fact, a considerable proportion of the series which exhibit definite trends leading to apparently non-adaptive or even mal-adaptive modification show parallel increases in dimensions. If these increases are advantageous, various associated features of a non-adaptive kind may, as was pointed out by Huxley, be looked upon as incidental results determined by the physiological factors responsible for heterogonic growth. The secondary consequences are tolerated on account of the greater importance of the primary basis of selection. How far such orthogenetic trends may be interpreted in this way is still uncertain.

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NEW BIOLOGICAL BOOKS

The aim of this department is to give the reader brief indications of the character, the content, and the value of new books in the various fields of Biology. In addition there will occasionally appear one longer critical review of a book of special significance. Authors and publishers of biological books should bear in mind that THE QUARTERLY REVIEW OF BIOLOGY *can notice in this department only such books as come to the office of the editor. The absence of a book, therefore, from the following and subsequent lists only means that we have not received it. All material for notice in this department should be addressed to H. B. Glass, Assistant Editor of* THE QUARTERLY REVIEW OF BIOLOGY, *Department of Biology, The Johns Hopkins University, Baltimore 18, Maryland, U. S. A.*

DIALECTICAL MATERIALISM AND SCIENTIFIC RESEARCH

A review of *The New Genetics in the Soviet Union*, by *P. S. Hudson and R. H. Richens*. Imperial Bureau of Plant Breeding and Genetics, Cambridge; Imperial Agriculture Bureaux, Penglais, Aberystwyth. 6s. (paper). 88 pp. 1946.

By Bentley Glass, The Johns Hopkins University

At the opening session of the Eighth International Genetics Congress, meeting in Stockholm this summer on July 7, the President of the Congress, H. J. Muller, spoke with fervor of the deepening clash between scientific truth and established political authority, a battle that has become intensified particularly in regard to the science of genetics. The twisting of the principles of genetics to suit political ends and the wholesale practice of "genocide" by the Nazis in their effort to eliminate minorities of whom they disapproved have outraged the conscience of humanity and led to the branding of such policies and actions as criminal. Muller turned from viewing this demoralization of scientific principle, to consider the struggle of science with authority in the U. S. S. R. He revealed that one of the conditions which the Russian authorities stipulated for the Seventh International Congress of Genetics, scheduled to be held in Moscow in 1937, was that no papers touching on human genetics were to be presented. To this impossible condition no self-respecting geneticist could agree—the Congress was held in Edinburgh, in 1939, instead.

Muller then called the roll of the Russian geneticists who have become martyrs to their scientific convictions. He decried that so-called "science" which condemns as treason any departure from the doctrine ordained by political authority. He reaffirmed the Geneticists' Manifesto of 1939 and asserted that loss of the right to establish truth by scientific methods, though in the name of a program for the betterment of man's social and economic welfare, is too great a price to pay.

As long ago as 1936, when Muller was still a guest investigator at the Institute of Cytogenetics in Moscow, the star of the agriculturist Lysenko was ascendant. Fortified in official esteem by his claims to have developed new and valuable varieties of wheat by vernalization, and to have changed the hereditary characteristics of plants by modifying their culture conditions and particularly by vegetative grafting, Lysenko and his associate Prezent attacked "Mendelian-Morganian" genetics. It was, they claimed, a delusion and a sterile intellectual pastime. Worst of all, it was, they asserted, anti-Darwinian and opposed to the truth of dialectical materialism.

In the treatise which is the subject of this review, the British authors published two years ago an objective survey of the course of the struggle. They have explained what the Russians mean by "anti-Darwinian," namely, contra pangenesis and contra inheritance of acquired characteristics; and they have also made clear the nature of the predicated harmony which must exist between "true science" and dialectical materialism. No chapter in the history of ideas seems more fateful than this accepted Marxian doctrine that material opposites or antitheses always exist in nature and that the unity of opposites leads historically to each new resolution of interacting forces, and so determines the outcome of every situation. In genetics, the doctrine appears to take the form: intrinsic nature + environment → character of organism. With this general statement few if any geneticists would differ. But agreement is not enough. One must, to be a good scientist in Russian eyes, use and apply the method of dialectical materialism in one's experimental work. Results, moreover, are to be judged not pragmatically, but ideologically. This attitude is so far from that current in the natural sciences that Hudson and Richens bend themselves crooked from leaning backwards in the effort to be fair and objective in their critique.

Hudson and Richens have examined, case by case

and experiment by experiment, the evidence upon which Lysenko bases his claim that classic genetics is unsound. Apart from dialectics and appeals to his own accepted authorities, these come to the following:

1. *The genetics of earliness.* Lysenko claims that a hybrid F_1 plant never matures later than the earlier of its two parents, and that in F_2 and later generations transgressive segregation for earliness is impossible. The evidence is against this. When the theory is qualified to hold only "under appropriate [and unspecified] conditions of existence," it becomes so elastic as to be untestable and scientifically useless.
2. *The prediction of dominance.* Lysenko's theory that those characters are dominant which are best adapted to the environment is contrary to the evidence. Lysenko's restriction of the hypothesis to early [and unspecified] stages in growth is again elastic and useless.
3. *Inevitable degeneration of pure lines.* Not proved.
4. *Rejuvenation by means of intravarietal crossing.* The evidence is satisfactory, but the varieties are not genetically pure, as Lysenko has assumed.
5. *Mutation induced by environmental factors.* May be true, but Lysenko's evidence is of little value.
6. *Non-random segregation.* "Mendelian" geneticists have established cases of this beyond doubt, but Lysenko's own evidence is not convincing.
7. *Non-segregating hybrids.* Same as for 6. These have many years ago been fitted into the frame of genetic theory.
8. *F_1 heterogeneity in crosses between supposed homozygotes.* Lysenko's results are not out of line with general genetic theory. The difficulty is to establish homozygosity beyond question, and even then mutation may produce exceptions.
9. *Differences between reciprocal hybrids.* No geneticist would dispute the existence of such differences in many instances—nor would they regard them as fatal to any of the established principles of heredity.
10. *Internal genetic variation.* Geneticists know many mechanisms that bring this about: chimaeras, unstable genes mutating in somatic tissues, somatic crossing over and segregation, etc. Such evidence does not conflict with accepted genetic theory.
11. *Mixed inheritance.* Cases of variegation, chimaera formation, cytoplasmic inheritance, virus infection, etc., are well established in current genetic theory.
12. *Graft hybrids.* Lysenko's citations of numerous experiments in which, after grafting, the hereditary characteristics of the scion have been permanently modified by those of the stock furnish his most compelling evidence. Controls are lacking for most of these experiments, however. It is imperative that such work be confirmed by other scientists, and the neglect of Western scientists to heed these spectacular claims and to confirm or disprove them promptly has given Lysenko unmeasured aid. Intervarietal and interspecific grafts of solanaceous plants, and even grafts between tomato and *Nicotiana* or *Datura*, are reported in the Russian work in each case leading to modification of hereditary traits, such as the production of nicotine in tomatoes, in succeeding generations.

In sum, Lysenko's evidence, with the exception of the reported effects of graft hybridization, is disproven or unconfirmed, or, where established, is not discordant with modern genetic theory at all, but only with his rather naive ideas of what geneticists regard as true.

In the second Russian conference on the genetics controversy, held in 1936 (the first was in 1929), the Mendelian-Morganian geneticists lost the day, and Muller, who had taken an active part in the defense, found it expedient to leave the country. In 1939, a third genetics conference met, and the charges against the "classical" geneticists were repeated. Nikolai Vavilov was made a special target for attack, and after the conference this world-renowned scientist was relieved of his posts and "disappeared" in Siberia.

Other "classical" geneticists, after a period of some alarm, continued their research. At the time of the study by Hudson and Richens, the situation seemed superficially so improved that they dared to express the belief (hope?) that Lysenko's influence was waning. This was a delusion.

Two weeks after the close of the Eighth International Genetics Congress, a fourth Russian conference resumed the controversy between dialectical biology and modern genetics. Lysenko reiterated his claims to have demonstrated the inheritance of acquired characteristics and denounced his opponents, including even Zhebrak, who had for years tried vainly to conciliate the parties by showing that Mendelism is not in fact inconsistent with dialectical materialism. Lysenko was completely victorious. The Central Committee of the Communist Party of the Soviet Union gave full approval to his views, and the Academy of Agricultural Sciences adopted a letter addressed to Stalin calling for the rewriting of university textbooks and the revision of courses in biology and related sciences, so as to remove all traces of *foreign* genetics and to bring all teaching into conformity with the views of Lysenko and his mentor, "the Russian Burbank," Michurin. Zhebrak recanted his heretical views in a letter to *Pravda*, reenacting the ordeal of Galileo in an earlier day. Other geneticists had already announced their complete submission to Lysenko's views. Still others were doomed. Two members of the Academy of Sciences, L. Orbeli, physiologist, and I. I. Schmalhausen, notable student of evolutionary processes, were relieved of their posts. The Institute of Cytogenetics in Moscow, headed by N. P. Dubinin, leader of Russia's *Drosophila* geneticists, was abolished. In short, research in genetics, except of the variety approved by Lysenko and guided by precepts of dialectical materialism, has come to an end.

The lines are now clearly drawn and every scientist must take his stand. In the pursuit of truth by scientific methods, is there an implicit right and obligation to follow the evidence wherever it leads? Or must one, in the interest of society, accept as unchallengeable certain dogmas, whether these stem from Church or Marx? Newton's laws of gravitation could not remain unmodified after the advent of Einstein. Must dialectical materialism and Lysenkoan heredity remain above discussion?

Hudson and Richens' critique and the translation of Lysenko's own book *Heredity and Its Variability*, made by Dobzhansky (see Q.R.B. 21: 279. 1946), should be read and pondered by every biologist.

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GENERAL BIOLOGY: PHILOSOPHY AND EDUCATION

MEANING AND NECESSITY: *A Study in Semantics and Modal Logic.*

By Rudolf Carnap. The University of Chicago Press. $5.00. viii + 210 pp. 1947.

The biologist Joseph Woodger has shown clearly that many of the interminable controversies of theoretical biology are rooted not in factual problems but in the scientific inadequacies of ordinary language. Biologists do not yet seem to have grasped the full importance for theoretical biology of Woodger's findings. But we may expect that general recognition of the ambiguities, contradictions, and hypostatizations that are part and parcel of everyday language forms will some day lead them to explore the powerful new linguistic techniques which logicians are creating. Probably the most productive single investigator of the linguistic problems of science is the logician Rudolf Carnap, whose amazing *Logical Syntax of Language* is classic in its field. In his latest book, *Meaning and Necessity*, Carnap has developed a meticulous new method for analyzing and describing the meanings of linguistic expressions.

Logicians customarily employ a way of meaning analysis called *the method of the name-relation*. They regard expressions in a language as *names* of (concrete or abstract) entities, in accordance with the three following principles: (1) Every name has exactly one entity (nominatum) named by it. (2) A sentence is about the nominata of the names occurring in it. (3) If a name occurring in a true sentence is replaced by another name with the same nominatum, the sentence remains true.

But this simple and intuitively sound method is not a satisfactory one. The first principle (1) contains an essential ambiguity. In certain contexts a name may have more than one possible nominatum, e.g., the name 'human' may be (and is) taken as the name either of the *class* Human or of the *property* Human. Furthermore, when we apply the second principle (2), we create a clumsy multiplicity of linguistic entities. Logicians usually construe (2) as meaning that if an expression is about a certain entity, then the expression must contain the name of that entity. Hence, in virtue of (1), to speak of two entities we require two different expressions as their names. For example, in the symbolic language of *Principia Mathematica*, Whitehead and Russell devised separate expression forms for classes ('$\hat{x}$(..x..)') and for properties ('(..x..)'). But worse still, when we apply the third principle (3) unrestrictedly, paradoxes arise. We give a simple example: Assume as true the sentence, "Wallace wished to know if Charles Darwin was the author of The Origin of Species." If, in this sentence, on the basis of the true identity sentence: "The author of The Origin of Species is identical with Charles Darwin," we replace the description 'the author of The Origin of Species' by 'Charles Darwin,' the resulting sentence, "Wallace wished to know if Charles Darwin was Charles Darwin," is presumably false.

Carnap devotes most of *Meaning and Necessity* to developing a method free from the difficulties of the method of the name-relation. He presupposes two operations distinguishable with respect to a given linguistic expression: (a) the operation of analyzing the expression to grasp its meaning; and (b) the operation of investigating the factual situation referred to by the expression, with the aim of establishing factual truth. That side of the expression which (a) alone establishes he explicates by his concept of *intension*; that side of the expression which (a) and (b) together establish, he ex-

plicates by his concept of *extension*. He does not regard linguistic expressions as names at all, but as having intensions and extensions.

Consider, for example, the sentence, "The author of The Origin of Species is human," which we symbolize by 'H(ιx)(Ax, os)'. (Completely to formalize this sentence in Carnap's notation, we would write it in the expanded form '(∃y)[(x)(Ax, os ≡ (x ≡ y)).Hy]∨ [∼ (∃y)(x)(Ax, os ≡ (x ≡ y)).Ha*]', where 'a*' symbolizes the null individual. For greater convenience, we use the abbreviated form.) In this sentence we see the following kinds of linguistic entities: (1) the *sentence* 'H(ιx)(Ax, os)'; (2) the *individual description* '(ιx)(Ax, os)', which is a symbolic translation of 'the one individual x such that x is author of The Origin of Species'; (3) the *predicators* 'H'—'human', and 'A'—'author of'; (4) the *individual constant* 'os'—(the book) 'The Origin of Species'; (5) the *individual variable* 'x'.

We now list the entities which Carnap designates as intensions and extensions of these various kinds of linguistic expressions. (We cannot follow here the reasoning which led him to this procedure; for this the reader must refer to the book.) Intensions of these expressions are, respectively: (1) the *proposition* The Author Of The Origin Of Species Is Human; (2) the *individual concept* The Author Of The Origin Of Species; (3) the *property* Human, the *property* Author Of; (4) the *individual concept* (the book) The Origin Of Species; (5) the *individual concept* x (the intensions of variables are of a special sort which Carnap calls value intensions.) Their extensions are, respectively: (1) the *truth-value* Truth; (2) the *individual* Charles Darwin; (3) the *class* Human, the *class* Author Of; (4) the *individual* (book) The Origin Of Species; (5) the *individual* x (the value extension of the variable 'x').

Note how Carnap, by his method of extension and intension, avoids the troubles inherent in the method of the name-relation. First, he clearly distinguishes questions of meaning (intension) from questions of fact (extension). Second, since he abandons the name-concept altogether, he does not preserve its essential ambiguity. Third, he eliminates the unnecessary multiplication of names which arises when the name-relation is applied. In the symbolic language, for example, he employs the neutral term 'H', whose intension is the property Human and whose extension is the class Human, and thereby renders superfluous special expressions ('Hx'; (x̂)(Hx)') for this property and its corresponding class. In addition, he shows how to translate the symbol language into an adequate word language (metalanguage) which also does not contain the terms 'property' and 'class.' Fourth, in his new method the antinomy of the name-relation cannot arise, since he does not use the concept of name; but since his concept of extension is similar to the latter in some respects, he gives special rules which govern the interchangeability of expressions and which prevent the occurrence of analogous antinomies.

In a short section of his book, Carnap discusses the logical modalities, that is, concepts like necessity, possibility, and contingency. These and other modalities he defines in terms of the basic concept of logical necessity. He introduces methods which permit combining the modalities with quantified variables, and outlines semantical rules for a system of modal logic.

Meaning and Necessity continues the tradition of fruitful, original research established by Carnap in *The Logical Syntax of Language*, *Introduction to Semantics*, *Formalization of Logic* and many other stimulating and provocative investigations. Biologists genuinely desiring to clarify the theoretical foundations of their science might profitably read what he has to say.

JOHN R. GREGG

SELECTIONS FROM THE ESSAYS OF THOMAS HENRY HUXLEY.

Edited by Alburey Castell. F. S. Crofts & Company, New York. 30 cents (paper). viii + 119 pp. 1948. This thin, pocket-sized book reprints a dozen of Huxley's essays, selected to represent the propagandist for science rather than the scientist per se. They range in date from the lecture "On the Advisableness of Improving Natural Knowledge" (1866) to the "Prolegomena to 'Evolution and Ethics' " (1894), and give a well-rounded picture of Huxley's notable vigor and clarity, even when he is discussing his doubts. These are essays every biologist should know, not alone because of their historical significance, but quite as much because they say with unmatched pungency many things still true or still problematical regarding the relation of science to man, both as an individual and a social being. The booklet is well printed, but the paper is, as usual in such editions, of the cheapest. Still, the collection is good value at such a price.

BENTLEY GLASS

MAN IN THE MODERN WORLD. *An Eminent Scientist Looks at Life Today.*

By Julian Huxley. A Mentor Book, The New American Library, New York. 35 cents (paper). 191 pp. 1948.

Nine essays from *Man Stands Alone* (QRB 16: 488. 1941) and four from *On Living in a Revolution* (QRB 20: 114. 1945) have been collected for this pocket book. They are: The Uniqueness of Man; Eugenics and Society; Climate and Human History; The Size of Living Things; The Courtship of Animals; The Intelligence of Birds; Science, Natural and Social; Religion as an

Objective Problem; Life Can Be Worth Living; Philosophy in a World at War; Darwinism Today; Tennessee Revisited; War as a Biological Phenomenon. Julian Huxley is by turns caustic, instructive, philosophical. He always writes well, and his ideas, agree with them or not, are stimulating. This is an excellent addition to the cheaply priced series of Mentor Books, which has done well by biology so far.

BENTLEY GLASS

LA PHILOSOPHIE DE CLAUDE BERNARD.
By A.-D. Sertillanges. Aubier, Éditions Montaigne, Paris. 42 fr. (paper). 256 pp. 1944.

The author of this book is a distinguished and highly competent professional philosopher, a member of a Catholic order, a Thomist and as such a teleologist. It is perhaps unfortunate that its reviewer is far from all of these things. Claude Bernard himself, however, was no practitioner of systematic philosophy. "As an experimenter," he wrote at one point, ". . . I avoid philosophic systems; but," he continued, "I cannot for that reason reject the philosophic spirit which, without being anywhere, is everywhere and, without belonging to any system, ought to reign, not only over all science but over all human knowledge."

Indeed, the philosophic spirit moved him to incorporate numerous, though often conflicting and confused, expressions of his own philosophical beliefs among his other writings. Many of these statements, together with commentary and interpretation by Sertillanges, are included in the present text, which attempts to demonstrate the fundamental similarity of Claude Bernard's philosophy to that embodied in the Thomistic doctrine.

The primary basis of comparison is derived from an analysis of Claude Bernard's interpretation of life. Bernard's great contribution to biological progress was his insistence that the "vital phenomena rest upon physico-chemical activities," that they "possess . . . their rigorously determined physico-chemical conditions," that the "science of vital phenomena must have the same foundations as the science of the phenomena of inorganic bodies, and that there is no difference in this respect between the principles of biological science and those of physico-chemical science."

For all his emphasis on these points, however, Claude Bernard was no mechanist nor materialist. "I admit, indeed," he wrote, "that manifestations of life cannot be wholly elucidated by the physico-chemical phenomena known in inorganic nature." And elsewhere: "physiologists can guide the manifestation of vital phenomena as physicists guide the natural phenomena, the laws of which they have discovered; but in doing so, experimenters do not act on life."

Neither, however, did he consider himself a vitalist. "Many," he said, " . . . assume a vital force in opposition to physico-chemical forces, dominating all the phenomena of life, subjecting them to entirely separate laws, and making the organism an organized whole which the experimenter may not touch without destroying the quality of life itself. . . . These ideas, which were current in other times, are now gradually disappearing; but . . . the so-called vitalistic adeas still remaining in certain minds are really an obstacle to the progress of experimental science."

He believed that, as a scientific determinist, he stood on middle ground between materialism and vitalism. "The spontaneity of living bodies," he wrote, "is simply an appearance and the result of a certain mechanism in completely determined environments. . . . The behavior of living bodies . . . is dominated by a necessary determinism linking them with conditions of a purely physico-chemical order." "We shall therefore define physiology thus: the science whose object is to study the phenomena of living beings and to *determine* the material conditions in which they appear. . . . It is our sole concern to study phenomena, to learn their material conditions and manifestations, and to determine the laws of those manifestations." "Vital force directs phenomena which it does not produce; physical agents produce phenomena they do not direct." "If I had to define life in a single phrase," he said, " . . . I should say: life is creation. . . . When a chicken develops in an egg, the formation of the animal body as a grouping of chemical elements is not what essentially distinguishes the vital force. This grouping takes place only according to laws which govern the chemico-physical properties of matter; but the guiding idea of the vital evolution is essentially of the domain of life and belongs neither to chemistry nor to physics nor to anything else. In every living germ is a creative idea which develops and exhibits itself through organization."

It is the "guiding idea," the "creative idea," that appeals to the Thomist, similar, as it is, to the *âme* in the Thomist doctrine of *composé humain* (Sertillanges' terminology). A development of this comparison is the primary enterprise of the present book.

There are various fallacies in Claude Bernard's logic, but his greatest weakness is his inability to specify what that "guiding idea," that "creative idea," represents. "First causes," he complained, "are outside the realm of science; they forever escape us in the sciences of living as well as in those of inorganic bodies." "What we call vital force is a first cause analogous to all other first causes, in this sense, that it is utterly unknown."

For the Thomist this is no great difficulty: his soul may be metaphysical, his directive agency may be divine. For some scientists, this may be a possible escape from their dilemma, but it is not necessarily the exclusive one for all scientists. The quotations already

cited indicate how uncertain Claude Bernard was as to his own choice. These are no matters of fact, but of conviction. Each scientist must decide for himself whether to retreat to the metaphysical, and even whether he considers the Thomistic interpretation of Bernard's thought valid or not.

Claude Bernard's own concern for freedom of decision was one of his major characteristics as a philosopher. He had a kind of obsession with freedom. His interest in the constancy of the internal environment was an interest in its significance as a condition of the free and independent life. "Living machines are . . . created and constructed," he wrote, "in such a way that, in perfecting themselves, they become freer and freer in the general cosmic environment." He was an ardent believer in free will, and opposed his "scientific determinism," which guaranteed it, to the "philosophical determinism" or fatalism which negated it. "Fatalism [philosophical determinism] assumes that the manifestation of any phenomenon is necessary and independent of its conditions, while determinism [scientific determinism] is the condition necessary to a phenomenon, whose manifestation is free." "Determinism," he asserted, "far from being a negation of moral liberty, is on the contrary a condition necessary to it as to all other vital manifestations."

But freedom, on the one hand, and school and system, on the other, are not always compatible; and this is as true for neo-Thomism as for other systems of thought. "I think that the best philosophic system," said Claude Bernard, "consists in not having any." The contemporary scientist holds a position in society where he is increasingly called upon to relate his own thinking to a larger philosophy. The biologist who is concerned with this obligation will find this interesting and well-written book highly stimulating. He will find it the more valuable, however, the more seriously he takes heed of Claude Bernard's forewarning to "biological science and experimental medicine . . . against invasion and domination by systems; because sciences submitting to these would lose their fertility and would abandon the independence and freedom of mind essential to the progress of humanity."

It is always a pleasure and a privilege to consider what Claude Bernard has written, and experimental biologists, deeply indebted to him as we are, must be profoundly moved by his thinking. His position may not always be consistent; it may not always even be clear. Indeed, he may beg the ultimate question, and yet he furnishes us with a hope for the future. He has set the task for the biologist of the future who can more successfully than he himself avoid the metaphysical escape, and yet find a way to analyze the apparent directive agencies "essentially in the domain of life," as well as through chemistry and physics. He gives confidence, too, that the accomplishment of such a task need not necessarily entail the sacrifice of a philosophical foundation for that moral liberty which is the necessary condition for further human progress.

JANE OPPENHEIMER

EVOLUTION AND ETHICS.

By Sir Arthur Keith, with a Preface by Earnest A. Hooton. G. P. Putnam's Sons, New York. $3.00 x + 246 pp. [1946] 1947.

This is an American edition of the book previously reviewed under the title *Essays on Human Evolution* (Q.R.B. 23: 48. 1948.) The present title seems more accurate than the original one. The American edition also includes a brief Introduction by E. A. Hooton, who lauds Keith as anthropologist and teacher but is noncommittal about the validity of Keith's point of view in these essays.

LIFE AND MORALS.

By S. J. Holmes. The Macmillan Company, New York. $3.00. xii + 232 pp. 1948.

Like Darwin, Wallace, Huxley, and many a biologist since, S. J. Holmes has become deeply concerned with the relation of the theory of organic evolution to ethics. He would not, I think, take umbrage at the characterization of his thoughts on the subject as critical and eclectic, rather than original. He owes much to the earlier thinking upon this subject of Darwin and Herbert Spencer, W. E. Ritter, Westermarck, W. K. Clifford, Reinhold Niebuhr, and numbers of others. Yet in all fairness one may say too that in certain respects he transcends the grasp of any of these, inasmuch as he has the accumulated knowledge of years spent in active participation in the development of present-day biology.

Holmes traces altruism to "deep roots" indeed. Even in the simplest living beings, and even in cells, the activities of life center about the two ends of "the maintenance of the individual and the perpetuation of its kind. In all life these are the primal roots of both egoism and altruism. . . . [They] are coeval instead of successive developments." This being so, it is easy to trace the evolution of the moral forces, by successive stages of reproductive concern, care for the young, and social cooperation, up to human levels. Religion becomes the handmaid of morals, not the source. Decisions upon controverted questions of right and wrong, such as divorce, birth control, euthanasia, and "vivisection," become relative rather than absolute, to be decided upon the balance of good and ill in its consequences and not upon a priori principles held to have general validity. Like Sir Arthur Keith in his recent book, *Essays on Evolution*, Holmes adopts Herbert Spencer's distinction between the "ethics of amity" and the "ethics of

enmity," both of which are generally operative. But Holmes thinks with far greater clarity on the subject than his compeer, and does not reach the unfounded conclusion that because enmity and war have been mighty forces in human history, they must therefore continue to be so, even though conditions are vastly different. On the contrary, Holmes is of the opinion that, although war may be morally justifiable under certain circumstances, we must distinguish between the conflicts of primitive people and modern states. "Viewed purely as a problem of evolutionary biology ... the case for the evolutionary value of war is certainly far from sufficiently clear to make warfare a moral duty which we owe to future generations." Our moral horizon is still expanding, and as we begin to comprehend the worldwide character of our task to adapt the social order to human needs, we must, in spite of pessimistic forebodings, work to improve both our social environment and our genetic heritage. The national groups whose existence threatens us with war are the acme of our group egoism, against which our group altruism must strive. We indeed owe gratitude for so stimulating an expression of an elder biologist's moral philosophy.

BENTLEY GLASS

NEW BIOLOGY. *Numbers 2, 3, 4.*

Edited by M. L. Johnson and Michael Abercrombie. Penguin Books, Harmondsworth, Middlesex. 1s. (Nos. 2, 3); 1s. 6d. (No. 4). 158 pp. + 8 pl., text ill.; 176 pp. + 16 pl., text ill.; 160 pp. + 16 pl., text ill. 1947; 1947; 1948.

These fine examples of science writing for the general public contain the following articles: Number 2: The War against Rodents (A. Barnett); The Biology of Sewage Disposal (Ll. Lloyd); Whales (R. F. Ewer); The Chemical Basis of Competition between Microorganisms (P. W. Brian); Weeds of Cornfields (Winifred E. Brenchley and H. C. Long); Bat 'Radar' (R. H. Knight); On Cutting Your Finger (M. Abercrombie). Number 3: How a Grasshopper Becomes a Locust (B. P. Uvarov); Forage Plants (D. H. Robinson); The Menace of the Roundworm (G. Lapage); Animal Life in Caves (R. S. Hawes); The Electron Microscope and Biological Research (V. E. Cosslett); The Biology of Ship Fouling (K. A. Pyefinch); Beasts of Burden (A. Parker). Number 4: Hybrid Vigour (E. Ashby); Are Statistics Really Vital? (R. B. Fisher); Insect Menace to Stored Products (J. A. Freeman); The Biology and Properties of Wood (E. W. J. Phillips); Vital Statistics of Fish Population (G. L. Kesteven); Milk: its Formation and Secretion (F. H. Malpress); Human Teeth and their Decay (Shirley Hughes). The rotogravure plates add much to the illustrations. Teachers of general biology will find here many interesting facts and relations that will appeal to students.

RÉCENTS PROGRÈS DES SCIENCES BIOLOGIQUES (EMBRYOLOGIE, CYTOCHIMIE, GÉNÉTIQUE ET BIOCHIMIE) AUX ÉTATS-UNIS. *Actualités Biochimiques, Number 9.*

By Jean Brachet. Éditions Desoer, Liège; Masson & Cie., Paris. 60 fr. (paper). 52 pp. 1947.

The justification for this little booklet lies in the eagerness of scientists in European countries isolated almost completely during the war years to become acquainted as quickly as possible with progress made in the United States in their particular fields of research. It is essentially a carefully compiled notebook presenting information collected by the author in the course of a brief visit in the summer of 1946 to some of the larger university laboratories and centers of research in the eastern United States. In content it ranges from mere notations of contributions made or work in progress, to well digested summaries and appraisals of the current status of problems of special interest to the author. There is no formal bibliography, but full citation of published work appears in the text.

ESSENTIALS OF BIOLOGY. *An Introductory Text-Book for Secondary Schools.*

By W. F. Wheeler. William Heinemann, London and Toronto. 7s. 6d. xii + 266 pp. + 8 plates; text ill. 1947.

"The aim of the book is to elucidate the principles underlying life, as manifested in the immense diversity of animals and plants." To attain this end, the writer has grouped the subject matter into animals, plants, and a third section, animals and plants. In order to awaken immediate interest in the student, man is taken as the first example under consideration. His anatomy, histology, and physiology are briefly discussed. Then the structure and physiology of the rabbit, frog, amoeba, hydra, earthworm, and some typical insects are described. At the end of each chapter there are suggestions for practical work with the organism under consideration. Plants are taken up in a similar fashion, with emphasis on the flowering plants. Algae, fungi, and bacteria are also included. The final part considers the relationships of plants and animals, their differences, and their environmental adaptations. Growth, inheritance, evolution, and classification constitute the remaining topics. There are a large number of illustrations, consisting of drawings and photographs, the former being original and rather good. The material is necessarily brief and in many places rather sketchy, although it is as accurate as can be possible under such a treatment. This book will probably fulfil the needs for which it was intended within the English school system.

HENRI C. SEIBERT

BASIC BIOLOGY FOR HIGH SCHOOLS.

By Carroll Lane Fenton and Paul E. Kambly. The Macmillan Company, New York. $3.24. x + 726 pp.; ill. 1947.

The authors of *Basic Biology*, a textbook for high schools, have set out to select material to develop all the fundamental principles of biology, to advance from observation and general ideas to understanding, and from studies in particular fields to the application of knowledge to the lives and relationships of men, to require students to use scientific method and to enable them to acquire scientific attitudes, and to do all this within a coherent, well-organized plan and in a popular, non-technical style. Such multiple aims might well daunt anyone. The marvel is that the authors have succeeded in almost every respect. So outstanding is this textbook that, within the limits of the reviewer's knowledge, only one of the very large number now extant can be regarded as equally good (see QRB 20: 169. 1945).

There are eleven units, as follows: Living Things and Their World; The Make-up of Organisms; Groups and Kinds of Organisms; Foods for the Living World; Feeding the Animal Kingdom; Organs, Systems, and Health; Producing New Organisms; Old Characters and New Ones; How Living Things Have Changed; Communities and Control; Using the World We Live In. Within these units all fundamental principles of biology are adequately covered except those of growth and development. The embryonic period of life in a human being, or other mammal, certainly could be studied with profit at the high school level. Accuracy of statement is generally high, although exception must be taken to the consideration of osmosis and diffusion as equivalent. On the whole, the book is rather elementary in level. The better high school courses may want a more advanced treatment of the subject matter.

Each chapter is concluded with a summary of the major new principles developed in it, and is followed by fact and thought questions, exercises, projects, and references for additional reading. The illustrations, both photographs and diagrams, are well chosen, graphic, excellently reproduced. Best of all, they are clear and uncluttered by irrelevant details and unneeded labels. The glossary is full, and the definitions given are reasonably accurate (except for *osmosis*) yet non-technical. The index is adequate.

In short, here is a textbook for high school biology courses that should appeal to young minds, and prepare them equally for the problems of their future and for further courses of instruction in this field. May it have a long and very extensive use!

BENTLEY GLASS

WORKBOOK AND LABORATORY MANUAL TO ACCOMPANY BASIC BIOLOGY.

By Paul E. Kambly. The Macmillan Company, New York. $1.60 (paper). iv + 220 pp.; ill. 1948.

All that needs saying about this workbook-manual, intended to accompany the textbook *Basic Biology for High Schools* by Fenton and Kambly, reviewed above, is that it is mainly of the "question-and-answer fill-in" type. A few, but by no means enough, experiments and observational studies are included. This is disappointing, in view of the superlative merits of the textbook.

BENTLEY GLASS

LEARNING GUIDE IN BIOLOGY.

By Gerald N. Bench, Veva M. McAtee, Ruth Morris, Elliott R. Downing. Lyons and Carnahan, Chicago, Dallas, Los Angeles, Wilkes-Barre, Atlanta, New York. $1.05, including teacher's test booklet (paper). x + 422 pp.; ill. 1947.

This workbook and laboratory manual for high school biology courses is not prepared to accompany any single textbook, but is instead keyed for use with 20 of the better textbooks most widely used at the present time. It is well organized, with stimulating exercises and many experiments and projects, although question-and-answer fill-ins predominate. More experiments could certainly be included with profit. It is too bad to find spiremes and Kallikaks still misleading the young, but most of the material is sound.

The diagrams and line drawings are good. Some of those depicting animals, with a particular system—digestive, circulatory, respiratory, etc.—superimprinted in red, are unusual and very effective.

BENTLEY GLASS

REVIEW DIGEST OF BIOLOGY.

By George M. Lash. Republic Book Company, New York. 25 cents (paper). iv + 120 pp.; ill. 1947.

This crutch to assist ailing students over the stile of examinations is virtually worthless. It consists of definitions of biological terms and of questions based on the definitions. Many of the definitions are acceptable, but many are not. Besides which, many terms one might expect to find are absent. Hence the crutch is too short to fit under the student's arm and is made of unsound wood to boot.

The last part of the booklet contains the New York State Regents Examinations in Biology from 1942 through 1947. These are, on the whole, good examinations of factual knowledge. They may be of some use to busy teachers as well as to hobbling students.

BENTLEY GLASS

PRACTICAL BIOLOGY.

By Edwin F. Sanders. D. Van Nostrand Company, New York. $3.00. x + 618 pp.; ill. 1947.

The units in this high school textbook cover the following topics: Background and Introduction; Earth Materials, Available Energy—How Living Things Use Them; Flowering Plants; The Flowerless Plants; The One-Celled Animals; Invertebrate Metazoan Animals; Vertebrate Metazoan Animals; Development, Improvement, and Elimination of Living Forms—Human Efforts to Help; Conservation of Natural Resources; Human Anatomy, Physiology, and Hygiene. Ther is no space given to animal reproduction, beyond a few casual references. Nor does vertebrate development receive much attention. The treatment of heredity is thin, and devoted chiefly to ethical precepts and the customary uncritical treatment of the Kallikak, Jukes, and Edwards families. Evolution is mentioned in a whisper as a "theory of race development" of whose truth the author is dubious.

The format of the book is good, and the illustrations taken from photographs have fared well; but the line drawings are frequently too small and unclear. All in all, the textbook cannot be recommended.

BENTLEY GLASS

BIOLOGY FOR SCHOOLS. *Fifth edition.*

By E. R. Spratt and A. V. Spratt. University Tutorial Press, London. 5s. vi + 424 pp.; ill. 1946.

British secondary school biology textbooks appear to be, as a rule, quite superior to American textbooks at the same level. They are more thorough, often more penetrating, and much less given to sugar-coating what American teachers and authors seem to regard as the unpalatable truths of biology. This *Biology for Schools*, now after 15 years in its fifth edition, would be no exception to the above rule except for one startling fact. In choice of examples, in clear explanations, in descriptive anatomy, physiology, and ecological relations the book is excellent—but from beginning to end there is not so much as a hint that either heredity or evolution exist, let alone that they constitute major aspects of biology.

BENTLEY GLASS

WE LIVE AND GROW. *Successful Living Series.*

By Seward E. Daw, Jessie F. McKee and Edna M. Aldredge; Pictures by Mildred Lyon Hetherington. Beckley-Cardy Company, Chicago. $1.28. iv + 156 pp.; ill. 1947.

This child's book is the First Reader of the Successful Living Series and follows the primer, *School and Play*. The stories in this series are aimed to provide vicarious social experiences desirable for the child at his particular age and grade level. It is hoped that these experiences will help the child to interpret life around him. In the present book the text is divided into six sections, each containing five stories. The first section includes stories of everyday living in home and school; the second is concerned with health; the third and fourth with nature-science; the fifth, with adventure and safety; the sixth, with farm life and farm animals. Nearly each page is illustrated with a color picture.

HENRI C. SEIBERT

TOWARD GENERAL EDUCATION.

By Earl J. McGrath, Paul J. Blommers, John C. Gerber, Walter R. Goetsch, James A. Jacobs, Lester D. Longman, Paul R. Olson, Goldwin Smith, Jamss B. Stroud, and L. A. Van Dyke. The Macmillan Company, New York. $3.00. xii + 224 pp. 1948.

Eight professors and two deans of the State University of Iowa, all profoundly interested in the character of general education at the university level, about two years ago constituted themselves an informal group to discuss and argue their views on the subject. Out of their deliberations, after more than a year, there came this book. It is centered about the concept of the student as a future citizen, and accepts the variety and inequality of the American student group as inescapable. The most impressive aspect of the book is that these ten men, who represent fields as diverse as education, English, physics, art, economics, history, and psychology, assert that their conclusions and recommendations result from unanimous agreement.

The program outlined is well worthy of a place beside the Harvard *Report* and other stimulating discussions of recent trends and revised goals in American higher education. Biologists, quite naturally, will look with most interest on the recommendations for the natural sciences. These are summarized in the following paragraphs.

The importance of understanding the philosophy of science cannot be overstressed. To understand and use the broader techniques of scientific research, to exercise care in the analysis of results, to appreciate the use of controls, to have a complete lack of bias and absolute sincerity, and to practise self-criticism are important indirect objectives of instruction in science. More direct aims are (1) to aid in establishing physical and mental health, through a knowledge of fundamental principles and facts; (2) to recognize the impact of modern science on material progress; and (3) to understand the use of scientific knowledge in controlling and solving problems, in cultivating intellectual curiosity and creative imagination, in developing critical judgment and a sense of satisfaction growing out of successful mental activity—and, above all, in attaining freedom from fear and superstition.

These objectives naturally divide the sciences into two groups, the biological sciences, on the one hand, and the physical sciences plus mathematics, on the other. *The student must be introduced to both.* The Iowa group approves neither extensive survey courses nor segmented courses taught by members of different departments, but insists on integration. The group therefore proposes courses that emphasize *principles*, one course to be organized in the biological sciences, and two in the physical sciences (chemistry and geology; mathematics, astronomy, and physics), the student being required to take the biological course and one or the other of the two physical science courses. The organization and management of each of these courses should be the responsibility of a single individual. The classes should be small (optimum, 15 to 20 students; not over 30). Laboratory work, because it is in general so time-consuming for value gained, should to a very considerable extent be replaced by good demonstration experiments —simple, easily followed by the whole class, and yielding positive, clear-cut results. Opportunities for individual work in the laboratory should be available, but might be restricted to students really interested in learning.

The subject matter treated in the course should be rigorously selected to stress fundamental principles. Historical material should be used freely wherever pertinent and related to valid principles. The treatment of material ought to be both descriptive and analytical. Intense effort must be expended to make it interesting and living. In biology, for example, there is little excuse for time spent on classification. "The course might first consider the unit of life, the cell, and cell metabolism, then multicellular organisms and more complex forms of life, always treating living matter as a dynamic system. The major portion of the course should be given to a study of man himself and his problems, with emphasis on reproduction, nutrition, development, heredity, organic evolution, and man's mental processes." There should emphatically be units on the psychological aspects of life, and on personal and public health.

To all this, in spite of a few minor differences of opinion, I heartily assent. It is worth general note that on several campuses in the United States courses of this very sort are now being organized and given. Their success or failure will be watched from all quarters.

BENTLEY GLASS

BIOLOGY: HISTORY AND BIOGRAPHY

HISTORY OF MEDICINE. *A Correlative Text, Arranged According to Subjects.*
By Cecilia C. Mettler; edited by Fred A. Mettler. The Blakiston Company, Philadelphia and Toronto. $8.50. xxx + 1215 pp.; ill. 1947.

The author has felt that instead of the usual chronological (and organic) arrangement of medical histories, a textbook should be adapted to the (arbitrary and temporary) divisions of the curriculum of our medical schools, and thus has actually tried to supply in one volume the separate histories of fourteen specialties (Anatomy, Physiology, Pathology, Physical Diagnosis, Medicine, Neuropsychiatry, Neurology, Dermatology, Pediatrics, Surgery, Gynecology and Obstetrics, Ophthalmology, Otology, and Rhinolaryngology). The results are most unfortunate and confusing. Preventive medicine, for instance, which is far more important that many of the specialties dealt with, has remained unmentioned. In view of her own numerous factual errors, the ahistorical attitude of "superiority" that the author adopts toward practically all periods and personalities of our medical past is particularly misplaced. If one adds that the author's style is indifferent, and that 1100 pages of double column printing are technically very hard to read, one will understand why the volume cannot be recommended for use as a textbook. Used with caution, it might, because of its richness of detail, be useful as a reference book to those who want to look up the history of some specialty.

ERWIN H. ACKERKNECHT

A HISTORY OF THE HEART AND THE CIRCULATION.
By Fredrick A. Willius and Thomas J. Dry. W. B. Saunders Company, Philadelphia and London. $8.00. xviii + 456 pp.; ill. 1948.

The authors have divided their book into three parts: 1) A history of our knowledge regarding the heart and circulation from the time of the ancient Egyptians to the first quarter of the twentieth century; 2) 20 special biographies of great "cardiologists" from Hippocrates to Sir Thomas Lewis (1881–1945); 3) a series of chronologies divided into subjects. The subtitles of Part III illustrate well the scope of the book: Anatomy of the heart and circulation; Aneurysm; Cardiac arrhythmia; Cardiovascular diagnostic signs and procedures; Congenital malformations and the embryology of the heart and circulation; The coronary vessels and their diseases; Electrophysiology and electrocardiography; The endocardium and its diseases; Heart block; Paroxysmal tachycardia; Pathology of the heart and circulation; The pulse; Surgery of the heart and blood vessels; Symptoms of diseases of the heart and circulation; Therapy of the heart and circulation.

The subject matter is intensely interesting and is competently handled by the two eminent cardiologists of the Mayo Clinic. Mistakes are surprisingly few for a work of this scope. The first five chapters are mostly compilations from standard texts like those of Garrison

or Castiglioni or Herrick's short history of cardiology, and are correspondingly impersonal. The book really gets under way with the 19th century. In these last three chapters of this part, forming three-fifths of the history, the authors evidently warm to their subject. Perhaps, then, they should have started with Harvey, just as the senior author, F. A. Willius, did in his excellent sourcebook *Cardiac Classics*. Among the biographies, those of little-known persons like Ibn-an-Nafis, Servetus, Wenckebach, Sir Thomas Lewis, etc., are most welcome, while one wonders how important the continual reprinting of such well-known lives as those of Harvey, Withering, or Laënnec may be. The chronologies on the above-mentioned subjects are so interesting and instructive that one feels that had the historical text been written in this form, that is, by making this part I, with the historical succession of facts only a chronology, and conversely had part I been made the third part, it might have produced an even more readable text. We bring this question of arrangement up only because it might serve authors faced with a similar problem of method in the future.

ERWIN H. ACKERKNECHT

ANDREAS VESALIUS BRUXELLENSIS: *The Bloodletting Letter of 1539. An Annotated Translation and Study of the Evolution of Vesalius's Scientific Development.*

By John B. deC. M. Saunders and Charles Donald O'Malley. Henry Schuman, New York. $5.00. 94 pp. [No year].

This is, as Saunders and O'Malley rightly state, the first work of Vesalius to appear complete in an English translation. (And when shall we see the *Fabrica*?) This *Letter*, being only one of the many contributions to 16th century discussions on how to let blood, finds its importance in the fact that, in describing the azygos vein, Vesalius here for the first time clearly emancipated himself from Galen.

A most excellent introduction brings this out, and sketches the general medico-historical background of the bloodletting discussion, the early medical history of the valves of the veins, and many other important details. It reminds us of the fact that Vesalius, though the father of anatomy, was no "anatomist" (non-practising specialist) himself, but, like most of his successors up to the 19th century, received many of his stimuli to seek new knowledge from his practical medical activities. The translation itself, generously provided with informative footnotes, is no less praiseworthy than the introduction.

ERWIN H. ACKERKNECHT

PLAGUE. *Laënnec (1782–1826), Inventor of the Stethoscope and Father of Modern Medicine.*

By Arthur N. Foxe. The Hobson Book Press, New York. $2.50. xii + 122 pp.; ill. 1947.

Under this thoroughly misleading title is offered a short novel based on the life of Laënnec, inventor of the stethoscope, and great French clinician. The novel is not bad. It is sensitive and intelligent, very lyrical, and those who like such bastardization of truth and fiction, will probably like it.

ERWIN H. ACKERKNECHT

FIGURES DE SAVANTS FRANÇAIS.

By Léon Binet. Vigot Frères, Paris. 52 fr. (paper). 118 pp.; ill. 1946.

The savants of this little publication are physiologists in whom the author has had a personal interest either through direct acquaintance, or indirectly through a mutual interest. Into the latter category falls Lavoisier, whose short biography is well interlarded with the author's own work in the field of metabolic measurements. Other biographies include those of Brown-Séquard, Charles Richet, Arsène d'Arsonval, and Charles Achard. In these short biographies, the nature of the work performed by each man occupies the major part, while the rest includes miscellaneous notes with some personal reminiscences in the case of contemporaries. There is no doubt that the author is enthusiastic about these men, for these are scarcely biographies so much as eulogies.

HENRI C. SEIBERT

L'OEUVRE DE LOUIS PASTEUR.

By Henri Simonnet, with preface by Pasteur Vallery-Radot. Masson & Cie., Paris. 220 fr. (paper). viii + 107 pp. 1947.

Here, in about 100 pages, are most competently reviewed the most important stages of Pasteur's scientific evolution: his studies on molecular dyssymmetries, on fermentations, on spontaneous generation, on bacterial diseases, viruses, and vaccines. These lucid and reliable "abstracts" of Pasteur's discoveries, freed from biographical details, will be most welcome to those who have not the time to plunge into the seven wonderful volumes of Pasteur's collected *Works*, edited by Pasteur Vallery-Radot (1923–1939), and yet who seek the contact with the thought of this scientific giant who never fails to amaze and stimulate the reader.

ERWIN H. ACKERKNECHT

LOUIS PASTEUR.

By Laura N. Wood. Julian Messner, New York. $2.75. x + 218 pp. + 8 plates. 1948.

This is a good biography, although it does not add appreciably to our knowledge of Pasteur. Recurrent biographies of distinguished men may be of value when the individual is a controversial figure, subject to varying interpretations; or when the passage of time reveals new information. This is not the case with Pasteur, whose scientific work and personal qualities are at least moderately well known. Therefore this book may be mainly recommended to those who would like a shorter and simpler biography of Pasteur than that given in the standard work of Vallery-Radot. For young people, it should fulfil its aim very well.

WALTER C. TOBIE

A SCIENTIST WITH PERRY IN JAPAN. *The Journal of Dr. James Morrow.*

Edited by Allan B. Cole. The University of North Carolina Press, Chapel Hill. $4.00. xxvi + 307 pp. + 9 plates. 1947.

At the time of his appointment as agriculturist to the Perry expedition, James Morrow was a young practicing physician in South Carolina. His observations upon truck gardening and other agricultural methods in Java, China, Okinawa, Honshu and Hokkaido, Japan gain interest and value because of his first-hand acquaintance with plantation methods and practices in the southern United States. Morrow must have been an unusually keen observer, or else in those days of very much less satisfactory interpreters he would have been seriously misled; his journal notes show him to have been remarkably accurate. The struggles Morrow experienced in trying to transport living plants by sailing ship to and from the Orient should make the reader appreciate, at least a little more, those plant introductions from which have come such a large proportion of all that we eat and wear. The author's very human observations upon Oriental and particularly Japanese characteristics and manners are also of more than ordinary interest in these days when the United States is so closely concerned with so much in Japanese life, agriculture, and government. In this connection the editor, who is a recognised scholar in his field, has rendered a particularly valuable service by setting out in a lengthy introduction the numerous reasons which motivated the United States Government to send the Perry and other expeditions to Japan.

ROBERT L. PENDLETON

HERMON CAREY BUMPUS. *Yankee Naturalist.*

By Hermon Carey Bumpus, Jr. The University of Minnesota Press, Minneapolis. $2.50. vi + 10 plates; text ill. 1947.

This is a thoroughly delightful biography of one of the most inspiring naturalists of recent times. Hermon Carey Bumpus is perfectly described by his son as "showing unusual insight and imagination in making out his problems, and clever invention and initiative in devising means for their solution." When one comes to understand the varied fields and the scope of the activities of the Yankee naturalist, one realizes how marked were his particular abilities.

As a boy in New England, his eager interest in animals and plants made his choice of biology at Brown University a thoroughly natural one, and from his enthusiasm as a student there later grew his marked talents as an inspiring teacher, not only at the same institution but also at Olivet College and at Clark University.

It is sometimes supposed that "absent minded professors" are not good business men; consequently it comes as a surprise to those whose acquaintance with Dr. Bumpus's work has been confined to his scientific achievements to learn that he served successfully as business manager of the University of Wisconsin and also as president of Tufts College, and that the present financial stability of both these institutions is largely due to his success in persuading potential patrons to contribute to the endowment funds.

But Bumpus was first of all a great naturalist. His enthusiasm over the study of living organisms in their natural environments made him a pioneer in the transformation of natural history museums from mere collections of specimens, in many instances understandable only by the curators, into the museums of today which offer so much of educational value to the public in general. The wide use of habitat groups came as a result of his creative imagination, to cite only one of the innovations which he adopted.

The opportunity to initiate such revolutionary ideas came with his appointment as assistant to Morris K. Jesup, then president of the American Museum of Natural History in New York. Before this assignment, however, he had already established a reputation by his rejuvenation of the Laboratory of the United States Fish Commission at Woods Hole, and of the Marine Biological Laboratory at the same locality.

Among H. C. Bumpus's numerous contributions to scientific theory, that one which appeals most strongly to the reviewer was accomplished while Bumpus was at Woods Hole. This was the biometric investigation of the introduced littorine, which, together with his similar investigation of variability in the English sparrow and the "mud puppy," constitutes the first use of biometry in this country as a tool for investigating natural selection.

But Bumpus is more likely to be remembered by the general public for his effort to make science readily intelligible to them. This effort expressed itself not only in the use of the habitat groups already spoken of, but also in the establishment of Trailside Museums in the national parks. To anyone who, like the reviewer,

has been in the habit of spending his vacations in national parks the importance of the Trailside Museum is obvious, for it enables one to gain an appreciation of the natural features of the countryside and an understanding of how they came to be. Bumpus's name has been given to a butte in Yellowstone Park, but his own work in science and education surely constitutes a more appropriate and more enduring memorial.

This excellently written biography by his son is of course not confined to scientific acheivements, but also treats of Bumpus' ancestry, his home life, his foreign travels, his avocations, and his sense of humor. He who wishes to learn more about these phases of his life and character is most strongly advised to read the book itself.

LUTHER BURBANK, *Boy Wizard.*

By Olive W. Burt; illustrated by Clotilde Embree Funk. The Bobbs-Merrill Company, Indianapolis and New York. $1.75. 188 pp.; ill. 1948.

One of a series of books depicting the childhood incidents of famous Americans, this book for children carries one through the years of Luther Burbank's youth up to his journey to California, and then, after a jump of 36 years, to a scene in Santa Rosa where the now-famous Burbank receives the homage of the local children on Burbank Day, California's Arbor Day. It is a book about a shy youngster with an insatiable curiosity and an inventive turn of mind, a youngster whose interest in plants and plant breeding carried him to fame. Well written and effectively illustrated, this somewhat fanciful biography should have a particular appeal to other children with similar inventive interests.

C. P. SWANSON

PETTICOAT SURGEON.

By Bertha Van Hoosen; foreword by A. E. Hertzler. Pellegrini & Cudahy, Chicago. $3.75. viii + 324 pp. 1947.

Born in 1863 on a Michigan farm, where she was also raised, Dr. Van Hoosen has lived long and with gusto. Practising surgery for almost sixty years in Chicago, she has experienced, suffered, and helped a great deal. Many doctors tend to make life rather hard for their colleagues. What they were (and sometimes still are) able to do to a woman who had nerve enough to become a doctor and a surgeon—and a successful one in addition—is fortunately kept on record by means of this autobiography.

Dr. Bertha Van Hoosen's travel experiences, especially in China and Japan, are most fascinating. Her straightforward, sometimes almost brutal way of saying the truth may shock some timid souls. It is actually the best part of a fine book on a life well spent.

ERWIN H. ACKERKNECHT

ECOLOGY AND NATURAL HISTORY

OBSERVATIONS ÉCOLOGIQUES EN FORÊT DE BASSE CÔTE D'IVOIRE. *Encyclopédie Biogéographique et Écologique, II.*

By Renaud Paulian. Paul Lechevalier, Paris. 600 fr. (paper). 148 pp. + 2 plates; text ill. 1947.

This ecological study of the tropical forest in the Ivory Coast is divided into three sections. The first describes the methods employed to gather the data; the location and description of the area chosen; certain meteorological conditions that prevail; and the characteristic stratification and type of vegetation. The second part, entitled General Ecology, describes seasonal variations in the fauna (principally arthropods); the fauna of the glades and their borders; that of the forest floor, the shrubs, and canopy. The third section is a description of the tree as an ecological milieu, with emphasis on its predation by a succession of forest insects.

The ground-inhabiting community of the clearings was found to be mostly predatory, while that of the grasses and weeds is mostly phytophagous. The former group receives its sustenance in major part from the rather dense fauna concentrated at the base of the rapidly growing vegetation. In the forest the surface was found to be poor in animal life, whereas in the intermediate zone, with a relatively stable microclimate, there exists an equilibrium between animal- and plant-consuming arthropods, although the density of the populations is still low. Many related forms which live on the ground in temperate climes are restricted here to the intermediate zone (e.g., carabids, staphylinids). The nature of the microclimate also favors considerable cryptogamic growth, with the result that the area abounds in mycophagous insects. The tree-top community is rather unique, in that most of its inhabitants are nocturnal and phytophagous. This nocturnality is especially odd, since one would expect these insects to stay away from an area of maximum light intensity.

This rather sketchy resumé of the salient points does not do full justice to all the data collected by the investigator. Anyone interested in synecology will find this a valuable contribution for comparison with other similar studies that have been conducted in forested areas of different biotic zones.

HENRI C. SEIBERT

FOREST INFLUENCES. *The Effects of Woody Vegetation on Climate, Water, and Soil, with Applications to the*

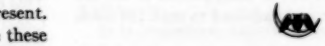
Conservation of Water and the Control of Floods and Erosion. The American Forestry Series.

By Joseph Kittredge. McGraw-Hill Book Company, New York, Toronto, and London. $4.50. x + 394 pp.; ill. 1948.

By forest influences are meant the effects of natural vegetation on climate, water, and soil. In this book the author aims to cover the influences of woody vegetation quite thoroughly, without attempting to include with equal completeness the many important effects of range vegetation on water and soil. As the author says in his preface, "The attempts at broad generalizations based on inadequate information have been the commonest sources of the controversies of past and present. In many cases the information needed to resolve these conflicts or to clarify the problems must be quantitative. Consequently every effort has been made to bring together numerical data in support of conclusions and, wherever possible, to express relations in equations as the most useful form of quantitative generalization." Sometimes it seems as if the author is more interested in developing equations or other mathematical expressions than in the influences themselves. However, the summaries at the ends of the chapters restore at least somewhat the reader's perspective. Certainly an enormous mass of literature has been covered by the author and here presented in brief to demonstrate points of view and to show the ranges within which the forest influences have their effects. In most cases, the statement of controversial subjects is extremely dispassionate—quite as an engineer would be expected to state it: conservative, non-partisan. Most of the figures are graphs. The opening statements at the beginning of each chapter are very effective in presenting the over-all picture of the subject of that chapter. As might be expected from the engineering point of view, the author devotes much attention to the limitations of measuring devices and to showing the wide range of results which are obtained from different styles and types of rain gauges and similar instruments. The first twenty chapters of the book are basic, while chapters 21 to 25, dealing with floods, erosion, the control of erosion, vegetation for erosion control, and watershed management and the protection forest are the logical development from the preceding runoff and stream flow data. These latter chapters are much easier reading for the layman and particularly for a non-mathematical reader, for in them there is no attempt to develop mathematical statements of relationships. One is annoyed somewhat by having to refer repeatedly to the appendix to learn the botanical names of many plants which are mentioned by "common" names only. Certainly the inclusion of the botanical names in parentheses following the common names would not be as unpleasant reading as the great mass of formulae in the earlier part of the book.

This book is written for north temperate regions and is based almost entirely upon literature from the United States. The appendix contains a bibliography of 381 items. An occasional reference is made to work in Europe or in Japan. Because of the inevitable development of tropical regions, where forest conditions and tree crops will have to be much more important in the land utilization picture than is the case in north temperate regions, it would seem that there is a place for greater emphasis upon tropical conditions. On the other hand, as yet there are doubtless insufficient data to make a discussion of the subject worth while.

ROBERT L. PENDLETON



THE EVERGLADES: *River of Grass. Rivers of America. By Marjory Stoneman Douglas; illustrated by Robert Fink. Rinehart & Company, Inc., New York and Toronto.* $3.50. x+ 406 pp.; ill. 1947.

At first thought it may seem strange to discover a book about the Everglades included in the series "Rivers of America." However, the author presents convincing evidence in her first chapter that this unique region of Southern Florida may indeed be considered a river—the only one of its kind in the world—one of water and grass. The book presents a history of "the Glades" in all its aspects, from relatively brief discussions of prehistoric and modern animals and plants to detailed accounts of Spanish colonization, the Seminole Wars, and the relatively recent attempts to drain much of the area. The early historical presentation centers around the Indians in a fascinating and yet inevitably depressing tale of their long, unequal struggle against the encroaching whites—a struggle in which the white man, despite his duplicity, failed for once to gain a complete victory.

The recounting of the fate of the Everglades as a natural region under the white man's control is just as depressing a tale as that dealing with his treatment of the aborigines. The effects of haphazard drainage operations and the dyking of Lake Okeechobee, which resulted in the partial drying-up of the Glades and the disastrous fires of recent years, demonstrate most graphically the need for regional planning in the development of such an area. As the author makes clear, the only solution for the continuing problems affecting all Southern Florida lies in treating the Everglades as a single natural unit, with a development and conservation program under unified control. The timely establishment in 1947 of the Everglades National Park in the southern part of the region is a major accomplishment in such a program. But it is not the complete answer. It is to be hoped that this excellent account of the area and its history may provide the needed stimulus for the establishment of an intelligent conservation program for the entire Everglades.

NORMAN S. GILES

THE CONSERVATION OF NATURAL RESOURCES. *A Textbook for Junior and Senior High Schools.*

By H. Basil Wales and H. O. Lathrop. Laurel Book Company, Chicago. $2.40. viii + 554 pp.; ill. [1944]; 1947.

This is a revised edition of a book originally published in 1944. However, on several pages one notes that the wording is still that of before V-E Day. In another place, however, the wording indicates that the section has been revised after V-J Day. In keeping with the subtitle, the book is cheaply printed on rather light paper with narrow margins. Nevertheless, for the most part the illustrations are good; however, in a number of cases more comprehensive and instructive legends could well have been used.

The authors have endeavored to inculcate the idea of conservation in all its phases, as can be seen from the titles of the "units": Unit I, Introductory Preview of Conservation; Unit II, Forest Conservation; Unit III, Soil Conservation and Agriculture; Unit IV, Conservation of the Range; Unit V, Water Resources and their Conservation; Unit VI, Wildlife Conservation; Unit VII, Conservation of Mineral Resources; Unit VIII, Conservation of Recreational, Scenic and Historical Resources; Unit IX, Carrying Conservation into Effect. Conservation in these broad aspects is indeed a very important subject, and the various topics are clearly and simply presented. At the close of each chapter is a section entitled "Activities and Experiences." If these suggestions and exercises suggested are used by the teacher, they should be very useful in relating the subject of the chapter to the actual life of the students. This book is written specifically for use in the United States. Nevertheless, it could with profit be read more widely. Hence it would seem desirable to avoid the use of the expression "white man"; this term might be replaced by the word "European" or "Caucasian" as a general term.

ROBERT L. PENDLETON

HYDROBIOLOGIA. *Acta Hydrobiologica, Limnologica et Protistologica, Volume I, Number 1, 1948.*

Edited by Gunnar Alm, H. d'Ancona, Kaj Berg, E. Fauré-Fremiet, F. E. Fritsch, K. Münster Ström, P. van Oye, W. K. Taylor, and N. Wibaut-Isebree Moens. Published by Dr. W. Junk, The Hague. G 40.- per vol. (1 vol. of 4 numbers per annum).

The first issue of this new journal devoted to hydrobiology, limnology, and protistology contains nine papers, 5 of them in English, 2 in German, 1 in French, and 1 in Spanish, as follows: Objectionable Algae with reference to the killing of fish and other animals (G. W. Prescott); *Microcystis Toxica* n. sp., a poisonous alga from the Transvaal and Orange Free State (Edith L. Stephens); Le Phytoplankton estival de la "Costa Brava" catalana en 1946 (R. Margalef); Algennachweis in Entenexkrementen (E. Messikommer); Thecamoebous Moss-rhizopods from New Zealand (H. R. Hoogenraad and A. A. de Groot); Die Photosynthese des Phytoplanktons vom Gesichtspunkte der Quantenlehre (R. Maucha); On the Bohemian Species of the Genus *Pedalia* Barrois (E. Bartos); A propos de quelques espèces du genre *Trachelomonas* Ehrbg. et du genre *Strombomonas* defl. trouvées aux Pays-Bas (A. Middelhoek); Thermal—vegetation and oecological—valences theory (V. Vouk). A final section, entitled Bibliographie, contains reviews of books and abstracts or original contributions in hydrobiology.

Four numbers, of about 100 pages each, will appear each year. Illustrations are all to be line engravings. The format and printing are excellent, the figures clear and well reproduced. It is a nuisance, however, that the pages are uncut.

NATURE AND MY CINE CAMERA. *Story and Lessons of Making Eighty Nature Films.*

By Oliver G. Pike. The Focal Press, London and New York. $4.50. 240 pp.; ill. 1946.

Nature and My Cine Camera follows Pike's earlier book, *Nature and Camera* (1943), which summed up fifty years of his experience in photographing flora and fauna and which was then acclaimed as the most informative work on that subject. In view of Pike's wide experience in this field, the present book, pertaining to the use of the motion picture camera in photographing nature, is a welcome addition and serves to bring the subject up to date.

This relatively small volume contains the stories and lessons of making eighty nature films, each an achievement. The knowledge derived from the author's experiences will aid and benefit the cine-photographer in choosing and selecting equipment, in writing scenarios, and finally in actually obtaining or shooting the picture. A glance at the chapter headings reveals the subject matter discussed: Cine Technique; Car and Camera; Making a Nature Film; Slow Motion; Speeding up Matters; Nature Cine Micrography; and eight more chapters directly concerned with the filming of numerous and varied birds and mammals. Within these chapters the material is covered in great detail and is accompanied by illustrations of actual film strips of high quality. *Nature and My Cine Camera* fully reflects the author's great love for nature photography, and his enthusiasm carries over to the reader. This book should prove helpful to both amateurs and professionals.

JOHN S. SPURBECK

NATURE QUESTS AND QUIZZES. *A Nature-Seeker's Handbook.*

By Raymond Tifft Fuller. The John Day Company, New York. $1.50. 64 pp. 1948.

This book will solve a problem for many a parent or teacher confronted with the task of keeping youngsters busy and profitably occupied. Three-quarters of the text is a directional listing of outdoor projects (a hundred of them), from finding fern prothallia or identifying four kinds of mice, to making and maintaining a woods garden or spying on a family of foxes. For those who prefer the "credit" method, a point system for competitive scoring is included. The remaining pages are given over to space for notes, and a 100-item questionnaire with (inverted) answers.

LORUS J. & MARGERY J. MILNE

ANIMAL HIDE AND SEEK.

Told and drawn by Dahlov Ipcar. William R. Scott, New York. $1.50. 36 pp.; ill. 1947.

A children's book consisting largely of illustrations of camouflaged animals for the child to find. This book, while not particularly impressive, should afford some amusement to small children.

EVOLUTION

MESOZOIC FOSSILS OF THE PERUVIAN ANDES. *Ellsworth Expedition Publication. The Johns Hopkins University Studies in Geology, Number 15.*

By Maxwell M. Knechtel, Edward F. Richards, and Mary V. Rathbun. The Johns Hopkins Press, Baltimore. $4.00 (paper). 150 pp. + 50 plates; text ill. 1947.

Invertebrate fossils of Upper Jurassic and Cretaceous age are described here. Most of the collections were obtained from northern and eastern Peru by expeditions led by Joseph T. Singewald, Jr., and by the Lincoln Ellsworth Expedition. Additional ammonites collected by J. A. Sinclair and T. Wasson from the same region are also described.

The work is divided into four parts. Part I includes an introduction, a list of collections, and a very complete description of collection localities. Part II, by Edward F. Richards, describes fifty-four species of Cretaceous echinoids, pelecypods, and gastropods, of which 1 echinoid, 19 pelecypods, and 3 gastropods are new. Much of the material is in a poor state of preservation and many identifications are considered tentative. Part III, by Maxwell M. Knechtel, describes 46 species of cephalopods, all of which are ammonites. Twenty-five are new species. Many of the ammonites are splendidly preserved. Part IV, by the late Mary J. Rathbun, describes a new species of a shrimp-like crustacean from the Lower Cretaceous. The descriptions are complete and the plates are good. The photographs of the ammonites are especially commendable.

W. A. COBBAN

THE GEOGRAPHY OF THE FLOWERING PLANTS.

By Ronald Good. Longmans, Green and Company, London, New York, and Toronto. $7.50. 403 pp. + 25 plates; text ill. 1947.

This closely written book contains an enormous amount of information regarding the distribution of the flowering plants of the world. It is quite impossible to do justice to it in a brief review. The author, in the Introduction, takes up the importance of plant geography, the vegetation and flora, the flowering plants and their classification, and the history of plant geography. Part I opens with a chapter on the geography of the world. Then comes one on the division of the world into floristic regions, followed by some general aspects of plant geography, including the evolutionary background, the cycle of distribution, endemism, discontinuity, age and area, and differentiation. There then follows a consideration of the distribution of families of plants: a number of different ones being taken up such as wide families, tropical families, temperate families, discontinuous families, endemic families, anomalous families. This is followed by a discussion of the distribution of genera of plants. In particular, Good discusses cosmopolitan genera, the number and size of genera, tropical genera, and temperate genera. A whole chapter is devoted to discontinuous genera; this is followed by one on endemic genera. Then the author considers the distributions of species, to include the distribution of species within genera and the significance of high species concentrations, cosmopolitan species, pan-tropical species, and other wide species, endemic species, discontinuous species, species pairs, narrowly restricted species, marine angiosperms, mangroves, and strand plants. Then, to illustrate more particularly his method of treatment, he discusses the history and distribution of the British flora, followed by the distribution of plants in an English county. He next proceeds to discuss the geological history of the world and the past distribution of the flowering plants, fossil floras, the Ice Age. The main portion of Part II is concerned with the factors of distribution: climatic; edaphic; dispersal of plants; changes of climate which have taken place in the world; and, finally, geographical changes. The author lays much stress upon the fact that for a long time prior to the glacial periods the climate of the earth seems to have been fairly moderate, almost from pole to pole. Then during the glacial epochs there was an intensification of the temperature drop from the equator toward the ice. This introduced many stresses into the previously more or less stabilized

flora. The author believes that plant distribution is best explained by Wegener's theory of continental displacement. A most interesting chapter is on the theory of tolerance, the purpose of which is to consider how far and in what manner those factors of distribution discussed can be made to provide a theoretical explanation of the geography of the flowering plants. Most helpful for the reader is the final chapter of Conclusions, which attempts to make a synthesis of all that has gone before and to present to the reader a brief but comprehensive summary of all the processes and events which have led to the state of plant distribution existing today. In the appendix are listed the discontinuous genera. There is a bibliography of 295 entries. The indexes of plant names and of persons and places seem to be unusually complete.

This book is very well and closely written. The paper and printing are excellent, and the rotogravure plates are from such well known books as Schimper's *Pflanzen-geographie* and Karsten and Schenck's *Vegetationsbilder*. The nine maps of the world are well drawn and present the facts clearly. However, their legends might be more easily read were they larger and placed in the upper right-hand corners. The numerous line drawings are clear and easily read.

ROBERT L. PENDLETON

LIFE THROUGH THE AGES. *A Visual Introduction to the Story of Change in Living Things. Stanford Visual Science Series.*

By R. Will Burnett. Stanford University Press, Standord University. $1.00 (paper). 48 pp.; ill. [No year].

The younger generation will certainly find its interest aroused by this evolution picture-book. It begins with a Calendar of the Ages, based on a reduction of the geological time scale to one year (7 days = 60 million years). The illustrations, each accompanied by a paragraph or page of text, are taken from the dioramas in the Palo Alto Junior Museum. They are accurate, but the animals do look rather obviously like clay models. The Carboniferous period has, for no apparent reason, been left out of the series, although it gets a sentence in the text. In addition to the series of illustrations of the typical fauna and flora of the periods, there is a small-scale reproduction of Huff and Strong's fine phylogenetic chart of the vertebrates (see QRB 18: 368. 1943), and there are graphic accounts of Diastrophism, Common Ancestry, Development through Adaptation, Peking Man, Neanderthal Man, Cro-Magnon Man, Early Cave Men, Migratory Man, Plainsmen, Lake Dwellers, the Farmer, the Migration of Races, the problems of want and suffering and the use of natural resources, etc. At the end there is a picture of the fine building occupied by this virtually unique children's museum. The paper and print (entirely in sepia) are better suited for graphic general effect than for portrayal of sharp detail. In spite of a few flaws, however, the book makes an excellent and most welcome addition to the high school and junior high school science library.

BENTLEY GLASS

GENETICS AND CYTOLOGY

SUBMICROSCOPIC MORPHOLOGY OF PROTOPLASM AND ITS DERIVATIVES.

By A. Frey-Wyssling; translated by J. J. Hermans and M. Hollander. Elsevier Publishing Company, New York, Amsterdam, London, and Brussels. $6.00. viii + 255 pp.; ill. 1948.

This is a translation of the author's well-known German edition of 1938, revised and brought up to date. Its importance in the field of cellular morphology is obvious, for it brings under one cover the various techniques used in, and the findings and interpretations resulting from, investigations of submicroscopic structure, together with discussions of attendant functions. It differs from the earlier edition by the inclusion of the results of electron microscopy, which as the author states have admirably confirmed and supplemented the data derived from the more indirect methods of x-ray diffraction, polarized light, double refraction, ultraviolet microscopy, etc.

The volume is divided into three sections. The first, dealing with the fundamentals of submicroscopic morphology, concerns itself with the properties of sols and gels at the molecular level. The second section discusses the fine-structure of the protoplasm, and the third the fine-structure of protoplasmic derivatives. The over-all result is a treatise that goes far in the direction of extending the field of cytology to the level of structural chemistry, a level to which cytology must go if the microscopically evident manifestations of the cellular components are to be understood in a functional sense. The reader probably will not agree with all of the interpretations of the author, but the thorough documentation, and particularly the inclusion of European work since 1938, makes the volume most useful as a reference. The translation suffers somewhat from awkward phrasing, but this in no sense impairs the usefulness of the book.

C. P. SWANSON

GENERAL CYTOLOGY.

By E. D. P. De Robertis, W. W. Nowinski, and Francisco A. Saez; translated by Warren Andrew. W. B.

Saunders Company, Philadelphia and London. $5.50. xii + 345 pp.; ill. 1948.

Cytology is generally considered to be a subdivision of morphology, but it is axiomatic that structure and function are inseparable. The union of cytology with genetics is but one instance of the successful blending of the functional and the structural into a single discipline, cytogenetics. The authors have taken this into account, and in this volume, which is a revised translation of an earlier Spanish text, they have incorporated the fundamentals of cellular physiology, cytology, cytogenetics, embryology, and histology. This obviously is somewhat of an undertaking, and one which can be handled only in a superficial manner in the limited space of a single volume. The treatment of these traditionally separate, but interrelated, disciplines in an integrated manner which cuts across the boundaries of the subject matter is much needed; the authors, however, have not been too successful in their treatment of the material, for, while some continuity is evident throughout the text, the subject matter is still compartmentalized to a considerable degree. Consequently, it is difficult to foresee where, within the perimeter of our usual college curriculum, such a text would find favor. It is too comprehensive for first year biology students, and too generalized to serve as a textbook for the more advanced undergraduate specialties which are usually offered. For a senior survey course or for independent reading, it has much to contribute, however, despite the brief treatment of the various topics forced upon the authors by limitations of space.

C. P. SWANSON

ADVANCES IN GENETICS. *Volume II.* *Edited by M. Demerec. Academic Press, New York.* $7.50. viii + 372 pp.; ill. 1948.

If anything, the collection of seven reviews in the second volume of this series exceeds that of the first volume in interest and general value. Ernst Caspari has provided a thorough and long-needed summary of the evidence for cytoplasmic inheritance. In some cases the transmission of cytoplasmic characters is due to plastid inheritance, in others to plasmagenes or viruses. In still other cases a general quality of the cytoplasm, termed the "plasmon," is transmitted. The investigations of the plasmon show that it is not in conflict with our present views of gene behavior. Studies are now shifting to an investigation of gene effects in different plasmons. Important from the evolutionary point of view is the evidence that the plasmon is not more stable than the genes.

Gunnar Dahlberg has contributed a theoretical and mathematical review of the Genetics of Human Populations. He has studied the deviations from the basic conditions of panmixia due to mutations, selection, assortative mating, intermarriage, and the effect of isolates. This contribution may be regarded as a briefer summary of the subject matter treated in the author's recent book, *Mathematical Methods for Population Genetics.*

A timely review of the Genetics of Cancer, by W. E. Heston, deals principally with the susceptibility or resistance to tumors manifested by inbred lines, chiefly of mice, and with mammary tumors, the milk agent, the genetic basis necessary for the growth of that virus, and the paths of gene action. Lung tumors, leukemia, subcutaneous and gastric tumors, and tumors of fowls, fishes, and *Drosophila* are treated more briefly.

The well-nigh incredible cytological phenomena found in coccids have been summarized, according to type, by Sally Hughes-Schrader. From a consideration of the coccid chromosome and its diffuse kinetochore and the probable primitive pattern of meiosis in in the group, she goes on to consider modifications and types of meiosis in the female and then in the male. In the great plasticity of the mitotic mechanism in the group, in the autonomy of chromosomes and even of chromatids in cell division, the multiple strand condition of the normal chromosome, and the variations of pairing and non-pairing chromosome association, the orientation of bivalents, the prevalence of an equational separation in the first meiotic division, normal segregation after asynapsis in male llaveiines and lecanoids, the linear orientation of chromosomes in mature spermatozoa, and numerous other unusual aspects, the coccids are an extraordinary group, the study of which has already thrown new light on the nature and evolution of chromosomal and mitotic behavior, and will yield yet more in future.

Ernst Mayr has written a brief review of The Bearing of Systematics on Genetical Problems: The Nature of Species. He has considered in particular the relation of species differences to the maintenance of isolation, and those special difficulties of the species concept which are due to the existence of sibling or cryptic species among animals. He criticizes the evidence for the existence of "physiological races" and finds it weak. He holds that morphological species criteria "will have to be supplemented by a study of ecological differences and of the completeness of reproductive isolation" in cases of doubt.

E. R. Sears has surveyed the Cytology and Genetics of the Wheats and their Relatives with special consideration of genome homologies, amphiploids, autoploids, and haploids, and the genetic characters of the tetraploid and hexaploid wheats.

In the last review of the volume, D. G. Catcheside has summarized the vast field of the Genetic Effect of Radiations. Although this review fills 79 pages, it is rather difficult because of over-great condensation. For those already familiar with radiation genetics, it

supplies an extremely valuable summary; but for others, probably Lea's book on the *Actions of Radiations on Living Cells* will be better. Almost any one or two of the 18 major topics Catcheside has considered would make a large enough subject for a good review.

BENTLEY GLASS

GENETICS.

By H. Kalmus, in Collaboration With Lettice M. Crump. Pelican Books, West Drayton, Middlesex. 1s. 6d. (paper). 171 pp.; ill. 1948.

This is a book written to acquaint the lay reader with the subject of genetics. The style is good and includes the use of many interesting examples of general principles that add much to the attractiveness of the book. In addition to chapters that describe what might be termed formal genetics, a discussion of the relationship of genetics to evolution, adaptation, and to various human problems of social and economic importance is presented. A glossary of terms and suitable discussions of probability are also included. The result is a presentation that should appeal to the non-technical reader, providing he is willing to make a reasonable effort to study and understand the material offered.

JOHN E. CUSHING

GENERAL AND SYSTEMATIC BOTANY

THE ARBORETUMS AND BOTANICAL GARDENS OF NORTH AMERICA. *Chronica Botanica, Volume 10, Number 5/6. By Donald Wyman. The Chronica Botanica Company, Waltham, Massachusetts; Stechert-Hafner, New York.* $1.50 (paper). Pp. 395–484 + 16 plates; ill. 1947.

The growing interest of the American people in garden materials for home and recreational use well justifies the issuance at this time of a list of the active arboretums and botanical gardens of North America, since these gardens are the primary source of botanical information available to the general public. As a reference list for professional horticulturists and landscape architects, this one is indispensable. The list of 90 gardens is alphabetical in arrangement, and each listing provides information as to function, acreage, number and kinds of species, ownership or endowment, and operating budget, together with other miscellany of general interest. It is prefaced by an introduction on the establishment and maintenance of an arboretum or botanical garden, an undertaking the magnitude of which few individuals thoroughly understand or appreciate. Wyman has performed a needed service in compiling this mass of detailed information, and presenting it in usable form.

C. P. SWANSON

BOTANICA GENERALE ED AGRARIA: *Tecnologica e Merceologica. Volume Three, La Sistematica delle Piante. I. Parte Generale.*

By R. Ciferri. Ulrico Hoepli, Editore, Milano. L.450 (paper). viii + 337 pp.; ill. 1946.

The reader unfamiliar with Italian will experience no difficulty in appraising the fundamental contribution made by this textbook to general botany, and to certain of its branches in particular. Merely by glancing over its index, he will learn that the author, Professor of the University of Pavia, Italy, has dealt with the historical and scientific basis of systematic botany (Part I); the entities of taxonomy (Part II); the evolution of cultivated plants (Part III); the principles of classification of cultivated plants (Part IV); and, finally, the cultivated plants of basic importance for the modern world (Part V), which all are credited to definite centers of origin in the two hemispheres.

This, then, is a work which sooner or later will find an English translator, and deservedly. Such a work as this ranks high for the data it includes, the bibliography it contains, the field it surveys. In addition, Ciferri is a vigorous writer to whom broad surveys and detailed studies in various branches of botany are equally well known. A constructive critic will unhesitatingly welcome the publication of a textbook of this kind at this hour.

Confirmed specialists, naturally, may find now and then statements with which they cannot fully agree. This is a foregone conclusion for works that cover broad fields of knowledge and necessarily make their own the conclusions of numerous other authors. Sharp students of the International Rules of Botanical Nomenclature, for instance, will not fully approve a classification of *Olea* that subordinates the series to the subspecies, considering that said Rules assign the series to a rank between the subsection and the species. In dealing with this genus, botanists with a strong bent for historical niceties will find much to their liking in Newberry's statement (*Proc. Linn. Soc. Lond.*, 150: 3. 1937) that olive oil was pressed by certain obscure peoples of Cyrenaica shortly after 3000 B.C. The Egyptians knew these nations, and it is fascinating to speculate whether these very same nations came ultimately to migrate to Crete and Southeastern Spain. Merrill is quoted by Ciferri to the effect that the Old and New World had in common no single cultivated plant with the exception, as noticed by the latter in a footnote, of a gourd. As a matter of fact, *Gossypium* was used for the same purposes both in the Old and New World, and sound evidence indicates that the coconut might well be endemic both to the Western and Eastern Indies alike, a possibility which is thoroughly compatible with the distribution of *Cocos* as such. Merrill's main contention stands, no doubt, but the proof upon which it rests needs qualification, and that qualification entails most interesting considerations about phytogeography

in general. The reviewer looks with less favor than the author upon the conclusions of Mangelsdorf and Reeves concerning the origin of maize (reason for which is contained in an article now in course of publication).

To discuss these and similar questions in the classroom and the laboratory would be impossible, were it not that Ciferri's timely and scholarly work makes it possible to hold the subject well in hand. That this work is successful, hardly needs repeating.

LEON CROIZAT

AN OUTLINE OF GENERAL BOTANY. *College Outline Series. Revised.*

By Harry J. Fuller. Barnes & Noble, New York. 75 cents (paper). x + 188 pp.; ill. 1947.

This revised edition of a standard botany syllabus has been brought up to date through the inclusion of new information arising out of experimental work. It still, however, follows the treatment of botany characteristic of the early 1900's, and because of its inadequacy and sweeping generalizations it should be placed on the "verboten" list for botany students.

C. P. SWANSON

ROCKY MOUNTAIN TREES. *A Handbook of the Native Species with Plates and Distribution Maps. Second Edition.*

By Richard J. Preston. The Iowa State College Press, Ames. $2.50. lxxx + 286 pp.; ill. 1947.

"The one major change in this edition has been to bring the nomenclature up to date." The latest International Rules of Nomenclature have been applied. Some few trees formerly classed as species have been reduced to the status of varieties or synonyms. The first edition was favorably reviewed (QRB 15: 489. 1940).

THE TREES OF YOSEMITE.

By Mary Curry Tresidder; illustrated by Della Taylor Hoss. Stanford University Press, Stanford. $2.00 (paper). xiv + 134 pp.; ill. 1948.

This is a small, beautifully printed book, generously illustrated with numerous linoleum block prints. While strikingly decorative, it is unfortunate for the stranger that some of the illustrations are of very doubtful assistance in recognizing the trees illustrated. One could wish for many more line drawings than the one page which has been included, and for some good photographs in addition. The text contains much of popular botanical interest about the trees and their site requirements.

ROBERT L. PENDLETON

THE AFRICAN VIOLET *Saintpaulia.*

By Helen Van Pelt Wilson; Drawings by Leonie Hagerty. M. Barrows and Company, New York. $2.50. 191 pp.; ill. 1948.

African violet enthusiasts, a rather recent but rapidly growing group of hobbyists, may be divided into two groups, those who can grow *Saintpaulia ionantha* with ease as well as exclaim over its beauty, and those who simply exclaim. Miss Wilson, in this first book on the Saintpaulias, attempts to remove some of the mysteries surrounding their culture, and so to merge the two groups of enthusiasts. Her success can only be measured by those who, in turn, attempt to translate her instructions into practice. The text appears certain to be greeted with enthusiasm, for the African violets are a "finicky" group which demands a particular treatment for optimum growth. The author handles the historical and cultural aspects of her subject well. The amateur, however, will have difficulty in determining what varietal name to give to a particular plant, for many of the varietal characteristics are not distinctive and clear-cut.

C. P. SWANSON

THE GENUS CREPIS. *Part One: The Taxonomy, Phylogeny, Distribution, and Evolution of Crepsis. Part Two: Systematic Treatment. University of California Publications in Botany, Volumes 21 and 22.*

By Ernest Brown Babcock. University of California Press, Berkeley and Los Angeles. (I) $4.00 (cloth), $3.50 (paper); (II) $12.00 (cloth), $10.00 (paper). (I) xii + 198 pp. + 2 plates; text ill. (II) x + pp. 199–1030 + 35 plates; text ill. 1947.

The Genus Crepis is a monograph in two volumes. The first of these is a small book of about two hundred pages, in which are the "discursive" parts of the monograph, while the second is a much larger volume that contains systematic descriptions of the sections and species of the genus. The monograph as a whole is the result of many years' research and has been prepared with extraordinary thoroughness and insight. Babcock began the study of the genus in 1915 and has continued it to the present time. The initial impetus came from the recognition on the part of Babcock that the genus *Crepis* has a low number of chromosomes that are easily studied, and that here in the plant world there might be a worthy counterpart of the fruit fly *Drosophila melanogaster*. Soon after its inception, the importance of the project was recognized by the California Agricultural Experiment Station and it was made a major part of the research program in the Division of Genetics. Support for the essential continuity of the study came thereafter from the Experiment Station. The present monograph covers the results of the whole study, and

contains in one work the significant material published in many preliminary papers.

For the general student of biology, particularly of its evolutionary phases, Part I (the first volume) will, of course, be most useful and stimulating. Babcock's experience with the genus *Crepis* has been similar to that of others who have attempted large-scale cytogenetic studies of genera. He has found himself entangled in the complexities of taxonomy, and has found it necessary, as an adjunct to the cytogenetic work, to prepare a taxonomic revision of the genus. Such labors are unavoidable, not only because of the partial or unfinished state of much of the world's taxonomic studies, but also because the cytogenetic work itself gives rise to new knowledge which must be incorporated in the taxonomic revisions. Volume II contains this taxonomic revision of the genus, and will be of value principally to students of systematics, and to institutions whose work is heavily weighted in that direction. The two volumes are, however, complementary, and must be examined together if one is to assay the full import of the monograph.

The number of species treated is 196, of which 113 were grown in cultivation for cytogenetic investigation. More than 5400 herbarium specimens are cited in the taxonomic descriptions, and the author states that probably as many more were examined without being cited. Throughout the years many thousands of individual living plants were examined in the field, and the results of those field observations have become a part of the author's thinking. The taxonomic study is buttressed also by extensive examination of type material in both European and American herbaria, so that it rests upon a sound evaluation of all the material resources available.

Part I begins with a comprehensive history of investigations in the genus *Crepis*, and shows the author's development of his problem. Following this comes a chapter on the taxonomic concepts used in the study as a whole. Chapter 3 states, in considerable detail, the criteria used in classification and phylogeny. Here the author makes it clear that morphologic criteria are his basic ones. Discussions following these preliminary chapters set forth the author's views on the phylogeny of the genus, its geographic distribution, notes on Asiatic-European plant migration and its bearing on the present distribution of *Crepis*, a study of endemism in the Old World species, and finally a general discussion of the origin of migrations and the evolution of the genus. Four Appendices are added, dealing with proposed problems for further research, the bearing of the evolution of *Crepis* on the origin of the ancestors of Eurasiatic crop plants, the bearing of the distributional history of *Crepis* on the region of origin of some angiosperms, and a brief essay on ovary anatomy as a phylogenetic criterion in *Crepis*. Part I closes with a list of references and an index.

Part II gives detailed descriptions of individual species and lesser taxonomic groups, with copious notes on geographic distribution, taxonomic relationship, and synonymy. There are comprehensive keys to the genus as a whole and to various species complexes. At the end is an index to cited Exsiccatae, and also an index to generic and specific names.

The whole monograph is copiously illustrated with excellent maps, anatomical drawings, and photographs of type and other critical specimens.

H. M. RAUP

PLANT PHYSIOLOGY

CHEMICAL COMPOSITION OF PLANTS AS AN INDEX OF THEIR NUTRITIONAL STATUS. *Imperial Bureau of Horticulture and Plantation Crops. Technical Communication Number 17.*

By D. W. Goodall and F. G. Gregory. Imperial Bureau of Horticulture and Plantation Crops, East Malling, Kent, England; Penglais, Aberystwyth, Wales. 9s. (paper). 167 pp. 1947.

Every chemist and physiologist, whatever may be his specialty, could add to his stature as a scientist by familiarizing himself with the technics which investigators of soils and of the nutrition of plants have evolved during the course of more than a century. The relation of plants to soil composition, moisture content, temperature, and hydrogen ion concentration is a field of chemical inquiry in which great progress has been made but in which also many fundamental problems remain to be solved. The future of mankind in every habitable part of the world will be greatly influenced by the extent to which plant nutrition can be understood in chemical terms, so that crop production, a perennial problem, can be safeguarded and perfected to the greatest possible degree.

In the present volume there will be found an account of constructive thought by students of plant nutrition. The shortcomings of quantitative chemical analysis as a basis for solving problems in biology, and the necessity of employing the living plant for analytical purposes are here set forth in a fascinating story which parallels in a striking way the experiences of students of animal nutrition. The present status of the micro-nutrients in plant nutrition is clearly delineated. This book should have a place in assigned reading for all graduate students in biology, physiology, geology, and every department of chemistry.

E. V. MCCOLLUM

THE FEEDING OF CROPS AND STOCK: *An Introduction to the Science of the Nutrition of Plants and Animals. Part I. The Plant; Part II. Soils and Fertilizers; Part*

III. The Nutrition of Animals and Man. Third Edition.

By Sir A. D. Hall; (I) and (II) revised by W. G. Ogg; (III) revised by John Hammond. John Murray, London; Transatlantic Arts, New York. $3.75 set. (I) x + 120 pp.; (II) x + 114 pp.; (III) xii + 116 pp. 1944.

Originally written by Sir Daniel Hall and published in 1911, these little books have been frequently revised. The latest edition, of which the present is a reprint, has been done under the supervision of the best agricultural scientists in Great Britain and can be considered to be thoroughly reliable. Sir Daniel's style of writing is unusual, and his books are almost worshipped by his countrymen. This is one of the reasons why unusual efforts have been made to keep this work in print. Using British terminology and illustrations, the books can hardly be considered of much interest outside of that country.

The three pocket-sized parts are designed particularly for the use of students in the agricultural short courses held in Britain from time to time for young people or adult farmers. There, such courses are known as "institutes." The work is suitable for use in connection with lectures and demonstrations. With but few line drawings and few halftones, and those poor, the descriptions of experimental procedures and demonstrations are a bit difficult for the average reader to follow.

ROBERT L. PENDLETON

ECONOMIC BOTANY

GARDENING. *A Complete Guide to Garden Making Including Flowers and Lawns, Trees and Shrubs, Fruits and Vegetables, Plants in the Home and Greenhouse. Revised Edition.*

By Montague Free. Harcourt, Brace and Company, and The American Garden Guild, New York. $4.00. xvi + 550 pp. + 31 plates; text ill. 1947.

Particularly for use in the north temperate regions of the United States, this book is all that its subtitle would indicate. In so far as any one book could possibly do, it covers excellently the entire field from landscaping to aquarium plants. The author, a graduate of Kew, is fully competent and has had the best of training and experience. Certainly the British professional gardener cannot be excelled—for serious training in the art of plant propagation and all other phases of gardening there is no training that can compare with that which is given at Kew. After the reviewer had worked under two Kew graduates, he realized how inadequate is the knowledge of gardening possessed by the average American amateur gardener. American gardeners are serious and very hard working, but most of them could profit in many ways be carefully following the sensible and clear instructions given in this book. The art of gardening in Britain is certainly farther advanced than it is here, and this book is the epitome of that art. And when one compares the gardens in Britain with those in the United States, the latter suffer by comparison with those of householders of a more or less equal position in England. There are repeated instances throughout the text where the author has added light humorous touches which make the book enjoyable reading even though one is not seriously intent upon gardening. The half-tone illustrations are superb and admirably illustrate the text. In addition, there are a great many line drawings which add clarity to the explanations. To every serious minded gardener, especially in the northern United States, this book can be heartily recommended.

ROBERT L. PENDLETON

AMERICAN HONEY PLANTS: *Together With Those Which Are of Special Value to the Beekeeper as Sources of Pollen. Fourth Edition.*

By Frank C. Pellett. Orange Judd Publishing Company, New York. $6.00. 467 pp.; ill. 1947.

When the first edition of *American Honey Plants* appeared in 1920, it was the only book in the English language to deal with the source of bee pasture, and it at once became *the* authoritative reference work on the subject. It has already been revised twice.

The present Fourth Edition has been greatly enlarged and rewritten to include the latest information available. Over 100 new plants have been added. It is now a complete and practical encyclopedia on honey plants and furnishes not only practical information but also digests of all the important literature in the field. The plants discussed are arranged in alphabetical order, and their scientific names are adequately indexed. Some 200 illustrations and maps add much to the value and appearance of the book.

ALBERT F. HILL

COMMERCIAL FLOWER FORCING. *The Fundamentals and Their Practical Application to the Culture of Greenhouse Crops. Fifth Edition.*

By Alex Laurie and D. C. Kiplinger. The Blakiston Company, Philadelphia and Toronto. $4.75. viii + 550 pp.; ill. 1948.

Successful floriculture, particularly at the commercial level, is no longer a matter of being the possessor of a "green thumb"; mass production, with its emphasis upon efficiency and economy, has demanded the application of foolproof scientific procedures which can be depended upon. Laurie and Kiplinger provide in their fifth edition (4th ed. reviewed, QRB 20: 274. 1945) an excellent basis for an up-to-date understanding of the cultural practices which have been thoroughly tested

including recently worked out principles of gravel culture, constant level subirrigation, and disease and insect control. Provided with a bibliography at the end of each chapter, the book should be useful to the specialist as well as to the beginner in floriculture who contemplates a career in this competitive field.

C. P. SWANSON

HEALING HERBS OF THE UPPER RÍO GRANDE.

By L. S. M. Curtin; Drawings by P. G. Napolitano. Laboratory of Anthropology, San Vincente Foundation, Sante Fe, New Mexico. $7.50. x + 281 pp.; ill. 1947.

Healing Herbs of the Upper Rio Grande, dealing with the native remedies of the Spanish-speaking Indians of the Southwest, is a welcome addition to the literature of ethnobotany and constitutes a valuable contribution to cultural anthropology in general and to our knowledge of drug plants.

The investigation was undertaken with the knowledge that the rapid decline of folk experience among the present-day Indians might well result in the total loss of much valuable information. The Southwest is an especially profitable region for ethnobotanical research in that the herb lore combines tribal knowledge, derived from experimentation, with folk lore and tradition handed down through the centuries from the original Moorish and Spanish sources.

The author discusses some 225 remedies, including a few of animal or mineral origin. Her treatment of the subject, based on talks with the Indian "médicas," adequately interprets the folk quality and often indicates its Moorish background; and it is also scientifically accurate from a botanical standpoint. Herbarium specimens were made wherever possible and these have been identified by Paul C. Standley of the Chicago Natural History Museum. The botanical nomenclature has been brought up to date by Dr. and Mrs. Joseph Ewan. The book contains 30 good illustrations, a bibliography, a general index, and an index of remedies.

ALBERT F. HILL

OUR FORESTS.

By W. H. Rowe. Faber and Faber, London. 12s. 6d. 173 pp. + 23 plates. 1947.

Convinced that ignorance of forests and forestry in lay circles is widespread and relatively complete, the author set out to do something about it. *Our Forests* is the result. This little book covers a lot of ground, presenting in simple language the story of British forests—how they evolved, how they were "mastered" (and despoiled) by man, and how they may be rehabilitated and extended.

The author rightly holds that for forestry to achieve its proper place in the economy of a community there must be developed in the people a mental quality which he calls "forest-sense." Many years ago a similar view was advanced by Sir Dietrich Brandis, who reasoned that for forestry to succeed it was necessary that the people in and near the forest be for and not against it. Ignorance regarding forests and forestry should decline, if this little book receives the wide reading that it merits.

H. J. LUTZ

THE PRACTICE OF SILVICULTURE. *Fifth Edition.*

By Ralph C. Hawley. John Wiley & Sons, New York; Chapman & Hall, London. $4.00. xii + 354 pp.; ill. 1946.

In this edition of his well-known college textbook, the author has attempted to revise the text thoroughly, so as to give expression to the new knowledge and the modern interpretation of old principles of silviculture. The author defines the purpose of silviculture as "the production and maintenance of such a forest as will best fulfill the objects of the owner." He then continues: "This book treats primarily of the production of wood crops and only where otherwise stated has it any other objective in view." It is encouraging to find that at least a few references have been made to forestry work in Java and India. However, since there is an increasing appreciation of the more rapid growth of trees in lower latitudes and of the fact that tree crops are almost the only way in which to utilize vast areas of poor soils in the humid tropics, it is a pity that the author has not made a greater effort to give the North American student of forestry some little notion of the importance of forestry nearer the equator and of some of the contrasting methods and practices. Certain it is that increasing numbers of North American foresters will be concerned with tropical forestry.

ROBERT L. PENDLETON

ADVENTURES IN MAN'S FIRST PLASTIC. *The Romance of Natural Waxes.*

By Nelson S. Knaggs, with Illustrations and Jacket Design by Frederic H. Kock. Reinhold Publishing Corporation, New York. $6.75. xiv + 329 pp. + 92 plates; text ill. 1947.

Scientists have often been accused of not being able to write for the layman. Here is a book which refutes that idea. *Adventures in Man's First Plastic* is at one and the same time a fascinating story of romance and adventure and a mine of factual information. The author, a chemist and veteran traveller, has long been a student and collector of waxes and, during the recent

War, went on several expeditions in search of new sources of those substances. He is, therefore, well equipped to write the story of the natural waxes of the world.

The chapter headings give an adequate idea of the scope of the work. Expedition to the Amazon tells of the adventures of a wax expedition in the dense jungles of the Amazon basin and gives an account of caiassú wax (from *Calathea lutea*); Wax Through the Ages traces the history and the many uses of wax from the Lost Wax of the Egyptians and early American civilizations to the present day; Brazil's Tree of Life treats of carnaúba wax; and Exploring the Big Bend and On To Mexico are concerned with candelilla wax. Other chapters include: Submarine Treasure, the Romance of the Whaling Industry and Spermaceti Wax; The Little Lady Lac Bug, the Story of Shellac and Shellac Wax; Chin-Lu and the Wax Caravan, Chinese Insect Wax; Ouricuri, the Ant Killer Tree, Ouricuri Wax; The Esparto Harvesters of North Africa, Esparto Wax; The Mysterious Bee, Famine Fighter of Mankind, Beeswax; A 60,000,000-Year Old Plastic, Ozokerite Earth Wax; Wax from an Ancient Forest, Montan Wax; and White Crystals from Black Gold, Paraffin Wax and Microcrystalline Waxes. A final chapter deals with some twenty natural and synthetic waxes of minor importance.

A technical reference section which is appended consists of a chart giving the properties of natural waxes, a bibliography, and an index. This book should appeal to the botanist, entomologist, geologist, archeologist, and chemist as well as to the non-professional reader.

ALBERT F. HILL

GENERAL AND SYSTEMATIC ZOOLOGY

ANIMALS ALIVE.

By Austin H. Clark. D. Van Nostrand Company, New York, Toronto and London. $4.00. viii + 472 pp.; ill. 1948.

Austin Clark has drawn upon his wide experience in biology to present a survey of the animal kingdom from an ecological viewpoint. The first of four parts is economic zoology, with both useful and harmful aspects given thoughtful treatment. The second section, on land animals, begins appropriately on an insect note, and covers their food relationships and those of the other invertebrates before progressing up the pyramid of numbers to birds, mammals, and reptiles. Part Three deals with fresh-water animals and amphibious forms, while the final section covers marine things and sea birds. The appended classification of animals may help to keep the tyro straight, but the full index with its generic and specific names to match the popular ones used provides the systematic specialists with the proper cues. That these steps are necessary will be appreciated at once by anyone who considers the vast variety of animals included by the author. The book abounds with factual matter—lengths, weights, shapes, colors, distribution, mode of capture, and especially food habits and uses or ecological relationships of animals. These provide a wealth of entertaining and informative reading that even the professional biologist will enjoy, while for general audiences who are not dismayed by an occasional popularized name (such as rhabdocoel), the book offers a stimulating panorama of the animals who share the earth with us.

LORUS J. & MARGERY J. MILNE

CHANTS D'OISEAUX ET MUSIQUES D'INSECTES. *Les Bois, Les Champs et Les Jardins; Vues sur le Monde Animal. VII.*

By Marcel Roland. Mercure de France, Paris. 75 fr. (paper). 220 pp. 1946.

Writing in the first person singular, M. Roland continues his series "Les Bois, les Champs et les Jardins (Vues sur le Monde Animal)" with the present (7th) volume of chatty description. He interspersed references to classical comments on bird and insect sounds with his personal observations and anecdotes. A little natural history and a brief mention of anatomical features related to song or stridulation are followed in most instances by syllabic representations of the notes themselves. Linguists might be interested in comparing the phonetics with similar attempts made, in England or Germany, where the same species are found—to see how French ears differ from others in their response to such natural noises. Throughout the book a light touch is maintained, whether the subject is a swallow or a cuckoo, a cicada or a dung beetle. The birds are grouped in Part One "En Forêt," the insects in the final section "Au Soleil." Scientific names are included in the descriptions themselves, but there is no index.

LORUS J. & MARGERY J. MILNE

THE SPECIES OF THE PSEUDOSCORPION GENUS CHELANOPS DESCRIBED BY BANKS. *Bulletin of the Museum of Comparative Zoölogy at Harvard College, Volume 98, Number 2.*

By C. Clayton Hoff. Museum of Comparative Zoölogy at Harvard College, Cambridge. $1.00 (paper). Pp. 473–550 + 4 plates. 1947.

This revision of the species of *Chelanops* studied by Banks from 1890 to 1914 redescribes and reassigns 26 of those 28 species in the light of modern taxonomic practice, which regards Banks' original genus *Chelanops* as virtually equivalent to the present superfamily

Cheliferoidea or to the suborder Monosphyronida. The 26 species now fall into 12 genera of the two families Chernetidae and Cheliferidae, two of the genera being new.

BEES' WAYS.

By George DeClyver Curtis; Decorations by Edwin Earle. Houghton Mifflin Company, Boston. $2.75. xii + 240 pp.; ill. 1948.

The thirty-seven years of beekeeping which back this book show clearly in the charm and philosophical comment with which the complex tale is told. George Curtis has observed closely, with less poetry but more exactitude than Maeterlinck, and his anecdotes point up the account at frequent intervals. His familiarity with and obvious respect for the bees, his intense interest in all aspects of their activities, gradually infuse the reader with an urge to get a hiveful and see these remarkable insects at first hand. The fourteen chapters provide an enthusiastic, easily-read tour of the colony, with emphasis always on the behavior of the bees themselves. So many facts in such a pleasant little book would seem to have justified an index for those who would like to check back on some half-remembered detail; unfortunately, there isn't any.

LORUS J. & MARGERY J. MILNE

LAND MOLLUSCA OF NORTH AMERICA NORTH OF MEXICO. *Monograph Number 3, Academy of Natural Sciences of Philadelphia. Printed by the George W. Carpenter Fund for the Encouragement of Original Scientific Research, Volume 2, Part 2, 1948.*

By Henry A. Pilsbry. Academy of Natural Sciences, Philadelphia. $12.00. xlvii + pp. 521–1112; ill. 1948.

This is the final instalment of the work which all students of North American terrestrial mollusca have been awaiting since its first part appeared nearly ten years ago. No comparable work has appeared since Binney's *Manual of North American Land Shells* over half a century ago, and in the meantime many significant changes have occurred—changes in taxonomy and nomenclature, and published descriptions of new genera and species.

The geographic scope of this work is approximately that of Wallace's Nearctic Region, except that the southern part of Florida, which is essentially Neotropical in its zoological affinities, has been included. This step has necessitated the inclusion of several essentially Neotropical genera, such as *Cerion, Macroceramus, Drymaeus,* and the highly colored *Liguus,* whose early extinction is now threatened by its popularity with tourists.

The great value of this work, however, lies in its treatment of the more widely spread Nearctic genera. As a result of his anatomical studies, the author has been able to dismember the old genus *Polygyra* into more than a half dozen new ones, leaving a mere handful of species in the southeastern states to bear the old name. The genus *Ashmunella* of Arizona and New Mexico, and *Oreohelix* of the Rocky Mountains and Great Basin, both of which were formerly thought to be closely related to *Helminthoglypta* of the Pacific coast, are given new affiliations—the former as a modified *Polygyra*, and the latter as related to the Asiatic *Camaena*. A new suborder, the Systellommatophora, has been erected for the Veronicellidae.

The reviewer was surprised to learn what a large number of European land snails have been introduced into North America by human agency, most of them being concentrated in the vicinity of Charleston, South Carolina. (Incidentally, *Cepaea hortensis* is not one of these. This European species, today found in such numerous localities in New England, Nova Scotia, and Newfoundland, was formerly believed to have been brought over by the Norsemen but is now considered to be circumpolar in origin and distribution.)

An interesting phase of the distribution of introduced molluscs is the rapidity with which they spread. A land snail from the Mediterranean, *Rumina decollata*, has been swiftly taking possession of our southern states. The northern, eastern, southern, and western limits of its range in the United States were determined by the present reviewer in 1940. In localities where it was unknown a few years previously, it is now quite abundant.

So far, no Asiatic land snails have established themselves in this country, but since this work was published the African *Achatina fulica*, which has become a pest in Ceylon and Guam, has been reported in Los Angeles. Its occurrence there illustrates the difficulty of keeping up with events.

A fuller discussion of general taxonomy would have been welcome in the monograph, since many of the taxonomic changes the author has introduced are far-reaching and affect other families than those of North America. For instance, the old family Helicidae, of world-wide distribution, has been broken up into half a dozen or so new families, and the question arises as to which of the Old World genera may be assigned to these new families and how many additional new families will be required to accomodate those genera which cannot be.

Helen Winchester's beautiful drawings of molluscan anatomy add much to the value of this work, and the photographs by A. Delwin Warden are the best this reviewer has ever seen. Altogether this work constitutes a landmark of monumental proportions in molluscan research.

JOSHUA L. BAILY, JR.

MONOGRAPH OF THE STROPHOCHEILIDAE, A NEOTROPICAL FAMILY OF TERRESTRIAL MOLLUSKS. *Bulletin of the Museum of Comparative Zoology at Harvard College, Volume 100, Number 1.*

By Joseph C. Bequaert. Museum of Comparative Zoology at Harvard College, Cambridge. $5.00 (paper). 210 pp. + 32 plates. 1948.

There is something fascinating about a snail over a foot in length when extended and crawling, whose shell may be six inches long, and whose eggs resemble in size, shape, color, and texture those of pigeons.

The author of this work has a habit of picking out unusual and interesting objects of study, and those who have accustomed themselves to think that his name on a title page is ample assurance of a treat awaiting them within will not be disappointed in the present case. The author has chosen to monograph a family of snails which flourishes on the Spanish Main, although a few of its more adventurous members have succeeded in crossing the Andes and establishing themselves as far south as northern Chile.

The text, of course, is highly technical, and will appeal chiefly to the specialist in this taxonomic group, but even those whose only interest in shells is esthetic will enjoy the illustrations. The reviewer feels most grateful for this book, upon which he expects to lean heavily in his own systematic work.

JOSHUA L. BAILY, JR.

AN ANNOTATED BIBLIOGRAPHY OF OYSTERS. *With Pertinent Material on Mussels and Other Shellfish and an Appendix on Pollution.*

By J. L. Baughman. The Texas A & M Research Foundation, College Station. 794 pp. Paper. 1948.

A comprehensive bibliography of oysters, a subject of prime scientific and economic importance, has long been needed. This work, compiled in a period of six months, will fill to some extent that need. The haste with which it has been assembled is responsible for many of its errors in detail, such as inadequate citation of illustrations, mistakes of pagination and title, etc., which mar the volume. Probably some of these mistakes are due to citation from secondary sources, but there are too many to permit the work to serve one of the important functions of a bibliography, which is the verification of incomplete references. A check of 25 titles of works dealing with oysters reveals at least 13 such errors. Some of them, along with the mangling of chemical formulae, can be explained because the printing was done by a small-town printing shop, unaccustomed to the precision necessary for such a task as this and unequipped for intricate printing.

The "annotations" consist of abstracts, summaries, and extended commentaries. Some short papers are reprinted entire, without any indication of that fact. Abstracts are often taken directly from the *Anatomi Record*, *Chemical Abstracts*, or *Biological Abstracts*, wi the abstracter's name retained; but anonymous quotations from abstract journals and summaries are not separated from the compiler's own comments. Since the greater part of the book's 794 pages consists of these annotations, many of them concerning rare or obscure papers, they comprise an original offering of some importance. It is unfortunate that the practice of publishing entire summaries, with original paragraph numbers omitted, is not generally indicated, and that more care was not given to checking transcriptions against the originals, for there are many places where the sense of a statement has been changed by an omission or garbled word. On p. 671 an abstract in French is hopelessly mangled. In many places the advance abstract of a paper, taken from the *Anatomical Record*, is published entire, together with the nearly identical abstract of the formal paper. This has added unnecessarily to the bulk of the text. Many important papers are cited without any abstract or comment whatever, and others receive such comments as "a very valuable paper," "a rather good general publication," etc.

Critical editing would have eliminated many peripheral references, such as those to general conchological treatises and faunal reports (Murphy's *Oceanic Birds of South America*, Ricketts and Calvin's *Between Pacific Tides*), and some of the newspaper articles, editorials, mimeographed circulars, and similar ephemeral items—which lend the work its claim to completeness at the expense of perhaps a fourth or fifth of the more valu literature concerning oysters and the physiology shellfish.

Despite these faults—and the unacknowledged qu tation and editing of summaries is a serious fault—this remains a very useful work, already proving to be of value to those in whose hands it has been placed. It is provided with subject and author indices. We cannot but marvel at the author's energy in assembling this mass of material. Nevertheless we must agree that to the author's own book (tu quoque!) applies his criticism of an equally amazing and fascinating compendium, Philpot's two thick volumes on *Oysters and All About Them*, which runs as follows: "A voluminous publication filled with repetitions, abstracts, and undigested results of inquiries of naturalists and government officials" (p. 480).

JOEL W. HEDGPETH

HANDBOOK OF MEDICALLY IMPORTANT MOLLUSKS OF THE ORIENT AND THE WESTERN PACIFIC. *Bulletin of the Museum of Comparative Zoology at Harvard College, Volume 100, Number 3.*

By R. Tucker Abbott. Museum of Comparativ

Zoology at Harvard College, Cambridge. $1.50 (paper). Pp. 243–328 + 5 plates; text ill. 1948.

Organisms may be of medical significance in three ways: they may be poisonous or parasitic in themselves; they may be harmless in themselves, but serve as intermediate hosts of other organisms which are poisonous or parasitic; or they may be a source of substances which have a beneficial use in medicine.

So far as I am aware, no mollusca fall into the third category mentioned above, although one of the Pilgrim Fathers has left us a recipe for "a metson to make a man's haire growe when he is balde," the chief ingredients of which are "bees and snayles." Man has always tended to fear that which he cannot understand, and it is perhaps not surprising that before the development of modern science such creatures as "snayles" were regarded with an awe akin to veneration. What a wonderful contribution to folk lore a history of quack medicine would be! But such a thought is a digression for which the reviewer begs the reader's pardon.

Medically significant mollusca are almost exclusively confined to the second of these categories. Many of the more common fluviatile mollusca harbor flukes or schistosomes that are deleterious to the health of the human species and domesticated animals. The importance of a knowledge of the life and habits of such mollusca is manifest at the present time, when so many citizens are returning home from war service in the Orient. Not only may some of these persons be infected with schistosomes to which certain of our native aquatic mollusca may be qualified to serve as intermediate hosts, but they might even inadvertently be the agent of introducing the exotic hosts or their eggs themselves.

The greater part of the highly technical work here reviewed is concerned with the Amnicolidae, a family of world-wide distribution. Many of its members do harbor schistosomes. There is also, however, a brief discussion of the Conidae, a family of marine gastropods whose bite is of considerable virulence. It is worth noting that while all the cones are provided with poison glands and ducts, in only a few species is the venom dangerous to man.

The author's object in compiling this work has been to meet an emergency by assembling all that is known regarding the part played by the mollusca in the dissemination of disease. The result is an interesting and significant contribution to the literature of preventive medicine.

JOSHUA L. BAILY, JR.

AN ANNOTATED CHECKLIST AND KEY TO THE AMPHIBIA OF MEXICO. *Smithsonian Institution, United States National Museum, Bulletin 194.*

By Hobart M. Smith and Edward H. Taylor. United States Government Printing Office, Washington, D. C. 50 cents (paper). iv + 118 pp. 1948.

"Checklists" vary tremendously in potential usefulness. Some are bare lists of the forms that occur in a particular area; others are near-monographic treatments of the animals included. The Checklist under review is closer to the latter extreme and should therefore be highly valuable to those interested in Mexican amphibians. The arrangement of material need not be discussed here, since it is essentially like that of the same authors' *Annotated Checklist and Key to the Snakes of Mexico*, which was reviewed in these columns previously (Q.R.B. 21: 93. 1946). The seriation of the families of the Caudata (in order, the Sirenidae, Ambystomidae, Salamandridae, and Plethodontidae) differs from that of Bishop, Stejneger and Barbour, and Noble. The Salientia are also arranged differently from the system of Stejneger and Barbour. No reasons for these changes are offered. There are a number of other novelties: *Triturus* is split into *Taricha* and *Diemictylus*; and a new suborder, the Plethodontoidea, is recognized.

Ninety-eight percent of the species included are monotypic (228 forms contained in 225 species). This condition is at variance with that in United States reptiles and amphibians, for which the proportions were 94 per cent in 1917 and 74 per cent in 1943 (Grobman and Tihen, *Amer. Nat.*, 78: 191–192. 1944). Either different systematic concepts have been applied or else much less is known of the Mexican fauna at the present time. From Smith and Taylor's Introduction it is clear that both causes are responsible. The number of forms per genus is 5.1, a figure not greatly different from that for United States reptiles and amphibians.

This report is certain to be extremely useful for those dealing with Mexican amphibians. Other checklist compilers might do well to include many of its fine features.

ARNOLD B. GROBMAN

BIRDS COLLECTED BY THE NATIONAL GEOGRAPHIC SOCIETY'S EXPEDITIONS TO NORTHERN BRAZIL AND SOUTHERN VENEZUELA. *Proceedings of the United States National Museum, Volume 97, Number 3219.*

By Herbert Friedmann. Smithsonian Institution, United States National Museum, Washington, D. C. Paper. Pp. 373–569 + 12 plates. 1948.

The collection of birds described in this report was made by Ernest G. Holt and his assistants on two expeditions, under the auspices of the National Geographic Society, in connection with the field work of the Venezuelan-Brazilian Boundary Commission. In the first expedition the party traveled the Orinoco from Ciudad Bolivar to the Casiquiare, down the latter to where it joins the Negro, and return. The second trip started on

the Amazon, went up the Negro and the Casiquiare, and then down the Orinoco to Ciudad Bolivar. The results of the study made on the approximately 3300 birds collected in this little known area of South America show that there is no marked distinction between the bird life of the Upper Amazon and the Rio Negro on the one hand and that of the Casiquiare and Upper Orinoco on the other. Of the 500 kinds of birds collected, only six show separate subspecific differentiation. Ten birds new to science were found, but have already been described elsewhere. In addition, the known ranges of some 30 birds have been extended: 11 birds are recorded as new to Venezuela and 5 as new to Brazil. The annotated list indicates the specimens collected and in many cases includes discussions of various taxonomic problems involved. Several plates of photographs taken on the expedition illustrate characteristic scenes and some of the bird life of the country traversed. An interesting novelty for such a strictly taxonomic and distributional paper of this sort is the inclusion of a common name for each of the forms discussed. For other information on the expeditions, the reader is referred to articles previously published in the National Geographic Magazine.

HENRI C. SEIBERT

HOW TO ATTRACT THE BIRDS. *Planting, Feeding, Housing.*

By Robert S. Lemmon, With Line Drawings by Roger T. Peterson, Tabea Hofmann and Henry B. Aul. The American Garden Guild and Doubleday & Company, Garden City, New York. $1.50. 126 pp.; ill. 1947.

This handy little book provides most of the basic information needed to attract birds to the home. Several types of bird houses are described, and their construction is explained in rather complete detail. Favorite plants, both as sources of food and as nesting sites, are listed, together with the species of bird that is likely to be attracted. This vegetational list is divided into regional areas of the United States, thereby making the usefulness of the book national in scope. Bird baths, feeding shelves, and other accouterments for this pleasurable pastime are also described. Line drawings illustrate most of the material referred to in the text.

HENRI C. SEIBERT

CATALOGUE OF TYPE SPECIMENS OF MAMMALS IN CHICAGO NATURAL HISTORY MUSEUM. *Fieldiana: Zoology, Volume 32, Number 4.*

By Colin Campbell Sanborn. Chicago Natural History Museum, Chicago. $1.00 (paper). Pp. 207–293; 1 plate. 1947.

The type, cotype, and lectotype mammals in the Chicago Natural History Museum include 15 marsupials, 20 insectivores, 37 bats, 2 primates, 1 edentate, 8 lagomorphs, 185 rodents, 28 carnivores, 2 hyracoids, and 10 artiodactyls, 308 in all. It is hoped that the present list will clear up the considerable confusion surrounding D. G. Elliott's types. The taxonomic classification, reference to publication, synonymy, museum number, collection data, and description of condition are given for each specimen. There is also a list of the type specimens arranged by locality; and a complete index is provided.

ALASKA'S MAMMOTH BROWN BEARS.

By Will H. Chase. Burton Publishing Company, Kansas City, Missouri. $2.50. 129 pp. + 16 plates; text ill. 1947.

The author of this book has long been familiar with the Alaskan brown bear, having spent much of his life in the area where they live. In this book he presents many field observations, organized in the form of the biography of an individual bear. This occupies a little more than half the book, the remainder being taken up with a series of hunting and similar anecdotes which have not been well edited and which leave an impression of disorganization with the reader. However, the book contains information that should be of interest to the hunter and amateur naturalist, and one cannot help but feel the sincerity of the author's interest in the conservation and study of these animals.

JOHN E. CUSHING

ZOO ANIMALS.

By E. G. Boulenger; Pictures by Maurice Wilson. Puffin Picture Books, Penguin Books, West Drayton, Middlesex. 1s. 6d. (paper). 32 pp.; ill. 1948.

This paper-bound volume of 31 pages deals with the limited group of mammals commonly found in our zoos. In order of presentation come primates, carnivores, ungulates, edentates, rodents, and marsupials. The straightforward, matter-of-fact descriptions of the appearance and habits of the animals are very well done, and the colored and pencil drawings accompanying the descriptions are excellent. *Zoo Animals* should do much to make a trip to the zoo more than just an outing for the younger generation.

C. P. SWANSON

LABORATORY MANUAL FOR INTRODUCTORY ZOOLOGY. *Revised Edition.*

By C. Courson Zeliff. The Evangelical Press, Harrisbur, Pa.; Keeler's College Stores, State College, Pa. $2.00 (paper). 154 pp.; ill. 1948.

The new edition of this laboratory manual (see QRB 20: 93. 1945) for a full year course in zoology, based on the study of animal types, has an additional exercise on the ammocoetes larva. The former key to the phyla has been replaced by L. Hyman's, and moved from the back to a place near the front of the book. Greek and Latin derivations for the scientific names are also now included in tables at the end of the manual.

ECONOMIC ZOOLOGY

HARNESSING THE EARTHWORM. *A practical inquiry into soil-building, soil-conditioning, and plant nutrition through the action of earthworms, with instructions for intensive propagation and use of Domesticated Earthworms in biological soil-building.*

By Thomas J. Barrett. Bruce Humphries, Boston. $2.50. 184 pp. + 7 plates; text ill. 1947.

This is indeed a rare book, part poetry, part fact, and part muddleheadedness. As to the poetry, if an author wishes to rhapsodize about the excretions of animals, that, no doubt, is his privilege. *De gustibus non est disputandum.* A reviewer, however, must observe that the essential facts about what Thomas Barrett so quaintly calls the "night-soil" of earthworms could have been presented in a somewhat simpler and considerably more direct style.

The most useful part of the book consists of the detailed and elaborate directions, complete with scale drawings, for making various types of culture boxes for raising "the domesticated earthworm," evidently a strain of the brandling or manure pile worm, *Eisenia foetida*. In fact, the figure from Hofmeister of *E. foetida* shown on page 25 is redrawn on page 95 as the "Domesticated Earthworm." The only significant difference is that under the second picture the acknowledgment to Hofmeister is omitted.

The book may also serve as a challenge for "soil scientists" to produce valid tests of the double thesis proposed, namely, that earthworms are the chief factor in soil fertility, and that it is practicable deliberately to increase the fertility of the soil by increasing the earthworm population. Barrett believes his book provides a "definite affirmative" to both of these propositions. Why he should think so is difficult to understand. He himself quotes Lunt and Jacobson as saying, in a recent paper from the Connecticut Agricultural Experimental Station, that "conditions favorable to the worms, are at the same time favorable to plant growth." Despite a wealth of authors quoted, and extensive tables giving chemical analyses of worm castings compared with various soils, there is almost nothing here to show the real extent of the part played by earthworms in hastening decay and mixing soil. That it is considerable has been known since before Darwin, but to claim that the fertility of the Nile delta is primarily due to earthworms is certainly an extravaganza.

As a clinching argument, Barrett points to the results obtained by one Christopher Gallup. This case is typical of the kind of evidence presented throughout the book. This Mr. Gallup increased his yield of corn from 80 to 196 bushels per acre in a period of over ten years. During that time he encouraged earthworms. He also manured heavily and regularly, harrowed in all weeds and litter at frequent intervals, and used selected seeds. He attributes his success "mainly" to the worms. With heavy understatement, Barrett concludes, "Maybe he has something." Maybe he has.

GAIRDNER MOMENT

A CATALOGUE OF INSECTICIDES AND FUNGICIDES. *Volume I: Chemical Insecticides. Annales Cryptogamici et Phytopathologici, Volume VII.*

Compiled by Donald E. H. Frear; foreword by F. F. Lininger. The Chronica Botanica Company, Waltham, Mass.; Stechert-Hafner, New York. $6.50 (paper). xii + 204 pp. 1947.

As pointed out in the preface of this work, the search for new insecticides and fungicides has been a haphazard affair. The search has been lacking in continuity of effort. One method of systematizing the approach to the problem is to compile and assimilate all of the work done to date, with the hope that trends and relationships may be recognized. This work represents a compilation of the results of biological testing on a group of approximately 10,000 substances. The compounds are arranged by code numbers. Following the code number of each entry is the name of the compound, its formula, toxicity and concentration tested when known, the insects against which it is effective, and references to published papers or patents. The coding system is explained fully in the introduction. An alphabetical index of all compounds listed is to appear in Volume II. This is a valuable catalogue for research workers in the fields of entomology, plant pathology, and chemistry and will spare them the necessity of long and tedious literature researches.

V. G. DETHIER

OUR ENEMY THE TERMITE.

By Thomas Elliott Snyder. Comstock Publishing Company, Ithaca. $3.50. xiv + 257 pp.; ill. 1948.

The title of this book implies a popular approach and discussion. The text, however, is largely technical, particularly in the earlier portions. While the paper is excellent and the typography above reproach, the half-tone illustrations leave a great deal to be desired. One could wish for more line drawings, like the one on p. 173, for such could with profit replace some of the

half-tones and the long detailed descriptions of building specifications. There are a number of irrelevant or inconsequential items. The organization of the material is rather poor. In short, the book seems to suffer from the lack of a competent and vigorous editor. Particularly in view of the title, it would seem very desirable to have in the early part of the book a clear, or even over-simplified description of the colonies and activities of the main groups of termites. Instead of giving so much space to various preventive treatments and methods of building to avoid termite damage or at least to reduce it, even to describing the various treatments used in different places for divers materials such as poles, lumber, and furniture, and the methods of preventing damage—it would be better to deal in general terms for all materials. An interesting point, made repeatedly, is that while termite damage in the United States is serious and may necessitate expensive repairs to timber structures, the damage is not likely to be of the catastrophic proportions which one might imagine from reading the advertisements and propaganda of certain firms which desire to obtain contracts from property owners for the control of the pests.

Like so many other books, this one is written primarily for the American reader. In some parts of the world, such as Siam, termites not only cause much damage but they are also of very definite advantage to the farmer, since the soils on the surface of the large termite mounds are relatively much more productive, when planted to garden and food crops, than the infertile soils of those localities on the whole.

ROBERT L. PENDLETON

HUNTING SMALL GAME.

By Bert Popowski. The Macmillan Company, New York. $2.95. xiv + 225 pp. + 16 plates; text ill. 1948.

If you like to go hunting, this book will provide pointers on how, when, and where to shoot rabbits (cottontails, snowshoes, or jackrabbits), squirrels, woodchucks, and prairie dogs. Additional chapters give guidance for training rabbit hounds, recipes for preparing the game, and precautions to be taken against tularemia. Throughout the text there is considerable information on firearms and ammunition, explaining and describing types of loads, of shells, their velocities, trajectories, and performances to be expected. This information will be useful to many hunters who talk a lot but know very little about the mechanics and physics of their firearms.

The continual use of the word "varmint" for these game animals is objectionable. At times the reader feels that the writer is falling over backwards to demonstrate that he is a sportsman and not just a killer, and that true sportsmanship is the ideal for which each hunter should strive. Here and there in the text, however, are suspicious circumstances that lead one to wonder whether the author follows his own precepts. Witness the time when the writer was on a *fishing trip* (italics mine) in Wyoming and ran into a colony of woodchucks: "The portly marmots were everywhere on the rock-studded hillside and we killed a half-dozen of them with no more weapon than the Colt handgun which we carried as anti-snake prevention." If statements such as this arouse no antagonistic feelings, then you will probably enjoy the book.

HENRI C. SEIBERT

BRIGHT WITH SILVER.

By Kathrene Pinkerton. William Sloane Associates, New York. $3.75. iv + 347 pp.; ill. 1947.

This biography of the Fromm brothers is at times a rather exciting one. The story begins when the boys were young and possessed by an unquenchable desire to raise foxes. None of them had even seen a cross fox; their only acquaintance was with the common wild red fox of their Wisconsin wilderness home. But with stubborn ambition they set out to breed foxes, and this narrative recounts their tribulations, their progress, and their failures from the time of their humble beginning to their achievement in developing the largest silver fox fur farm in the world. The brothers decided to strive for bright silver pelts, in spite of the disfavor with which this variety was looked upon by the fashion world. With characteristic purpose they kept working toward their goal until it was finally recognized that the silver furs developed at the Fromm farms were undeniably superior to those preferred by current taste.

Along with fox farming the brothers raised ginseng, a root cherished in the Orient, in order to finance their fox-raising endeavors. Now they also possess the largest ginseng farm in the country. The battles against falling markets and other financial worries, the fights against distemper and encephalitis in the fox and root rot in the ginseng, make entertaining reading once the preliminary historical background of antecedents is passed. [Unfortunately, the copy at hand has some pages missing, skipping from p. 294 to p. 317, thereby preventing the reader from learning what Myrna Loy was doing at one of the biggest auction sales in the country.] Numerous illustrations depict the progressive development of the farm, its animals, the pens, the harvest, the fur sales, and the men responsible for this profitable enterprise. For the biologist, there are some data on fox life that are interesting; the veterinarian's battle against epidemics reads like a story from *Microbe Hunters*; the information on selection is too scattered for useful analysis. All in all, this book should be read for pastime only.

HENRI C. SEIBERT

BIRD DOGS.

By Ray P. Holland; illustrated by Fred McCaleb. A. S. Barnes & Company, New York. $5.00. xiv + 204 pp. + 36 plates; text ill. 1948.

As its title shows, this book describes and discusses the various breeds of bird dogs in use in the United States today. It includes, in addition, chapters on the training of dogs, field trials, the registry of dogs, how to buy dogs, and other pertinent items. The illustrations are numerous and good, and the author's style and ability are in keeping with his well-established reputation as a sports writer. The book should be received favorably by all who are interested in the subject.

JOHN E. CUSHING

RAISING LIVESTOCK.

By Walter H. Peters and George P. Deyoe. McGraw-Hill Book Company, New York and London. $3.50. x + 519 pp.; ill. 1946.

This is a modern book of wide and comprehensive plan that should be of great value to individuals interested in the practical solution of problems associated with the raising of livestock. The authors have in this one volume organized references and discussions of essentially all pertinent and up-to-date information on livestock raising, ranging from an introductory discussion of the nature of the business, through the selection of livestock and the handling and caring for it, to marketing and using the finished products. The material is clearly presented; and there is no doubt that the book will prove to be of great value to livestock raisers, whether novitiate or long experienced.

JOHN E. CUSHING

THE HORSE OF THE AMERICAS.

By Robert Moorman Denhardt. University of Oklahoma Press, Norman. $5.00. xviii + 286 pp. + 20 plates; text ill. 1948.

This book presents, in an exceedingly satisfactory manner, an account of the horse in the Americas from the time of its introduction to the present, including discussions of various breeds and many pertinent points relating to horses and horsemanship. The author is obviously acquainted with a wealth of detailed information acquired through careful research, and without which he could not have written such a good book. While based upon detail, however, the material presented is not at all heavy, but is such as to clearly and neatly engage and hold the reader's interest throughout. Anyone, whether specifically horseman or not, who would like to learn more of the history and influence of the horse in the New World will find this authoritative account excellent, both as to presentation and information.

JOHN E. CUSHING

THE HORSE OF THE DESERT

By William Robinson Brown, with an introduction by Major General James G. Harbord and Henry Fairfield Osborn. The Macmillan Company, New York. $10.00. xxx + 218 pp. + 45 plates. 1947.

This book, originally published in 1929, has now been reprinted in a form that should make it more readily available to a wider audience. As noted by the publisher, it represents the only book devoted to the Arabian horse and has been written by an outstanding authority on this subject. The volume is well illustrated and includes a wealth of information about the Arabian origins of this breed as well as its position in the United States in 1929, particularly with reference to its superiority as a cavalry horse. The work would seem to be of most appeal to horsemen, rather than to the general reader.

JOHN E. CUSHING

INTRASEASONAL AND INTERSEASONAL VARIATIONS IN AVERAGE WEIGHT OF COLUMBIA RIVER CHINOOK SALMON (ONCORHYNCHUS TSCHAWYTSCHA), 1939–1945. *Special Scientific Report Number 34.*

By Ralph P. Silliman, Willis H. Rich and Floyd G. Bryant. United States Department of the Interior, Fish and Wildlife Service, Washington, D. C. Paper. 33 pp. 1947.

RED TIDE. *Progress Report on the Investigations of the Cause of the Mortality of Fish Along the West Coast of Florida Conducted by the U. S. Fish and Wildlife Service and Cooperating Organizations. Special Scientific Report Number 46.*

By Paul S. Galtsoff. United States Department of the Interior, Fish and Wildlife Service, Washington, D. C. Paper. iv + 44 pp. + 9 plates. 1948.

DEVELOPMENT OF FISHERY STATISTICS IN THE NORTH ATLANTIC. *Special Scientific Report Number 47.*

By George A. Rounsefell. United States Department of the Interior, Fish and Wildlife Service, Washington, D. C. Paper. ii + 28 pp.; ill. 1948.

OUTLOOK FOR THE ALASKA HERRING FISHERY IN 1948. *Special Scientific Report Number 52.*

By L. N. Kolloen and C. H. Elling. United States Department of the Interior, Fish and Wildlife Service, Washington, D. C. Paper. 26 pp.; ill. 1948.

ANIMAL MORPHOLOGY

TEXTBOOK OF ANATOMY AND PHYSIOLOGY. *Second Edition.*

By Catherine Parker Anthony. The C. V. Mosby Company, St. Louis. $3.75. 542 pp. + 5 plates. 1946.

This book grows out of the necessity to teach a course in anatomy and physiology to nurses. The author, who is a higher authority than the reviewer regarding what nurses should know, cannot be criticized for her choice of subject matter. Much thought has been devoted to classification and vocabulary. The reviewer, a physiologist, tends to classify the book as a very simple anatomical textbook; nevertheless, the functions of organs are described concisely and essentially correctly. There are mistakes of course, e.g., "If the craniosacral fibers (of the autonomic system) depress a *gland*, the thoracolumbar fibers stimulate it and vice versa." There is a tendency to deal with subjects (intelligence, unconsciousness, will, etc.) which most professional textbooks avoid; yet one must admit that these are important topics.

The series of questions and answers included with the book may be quite useful to many. But personally, the reviewer does not approve of such tests for advanced students, although others do. Among the answers, there are a few which are not correct or at least not known to be. For example: "Of the parts of any neurone which is the first to receive and transmit the nerve impulse? Axon, cell body, or dendrite." In the answer book, "dendrite" is given as correct, an answer that is debatable. I feel that the student should be permitted to debate.

On the whole this book represents a very creditable effort to meet the needs of a particular student group.

CHANDLER McC. BROOKS

ANATOMY AND PHYSIOLOGY LABORATORY MANUAL AND STUDY GUIDE. *Third Edition.*

By Barry Griffith King and Helen Maria Roser; section on Endocrines rewritten by Erwin P. Vollmer; illustrations by M. Cartwright Baker. W. B. Saunders Company, Philadelphia and London. $3.00. vi + 267 pp.; ill. 1948.

Although this is primarily a laboratory manual for nurses' courses in the subject, it is sufficiently broad in point of view and extensive in coverage to serve in general courses in human anatomy and physiology, too. The principal change from the second edition (see QRB 18: 289. 1943) is the complete revision of the unit on the endocrine glands, made by E. P. Vollmer. An *Instructor's Supplement*, containing lists of references and needed charts, models, histological sections, preserved materials, fresh materials, and sources of supply is a helpful addition to the manual.

BENTLEY GLASS

ANATOMY, HISTOLOGY AND EMBRYOLOGY. *Fiat Review of German Science, 1939–1946.*

By Philipp Stöhr, Jr. Office of Military Government for Germany, Field Information Agencies Technical. Paper. xii + 148 pp. 1947.

This small booklet is an extremely condensed but useful introduction to a considerable literature in the related fields of anatomy, histology, and embryology, published in Germany during the war years, and which received little or no circulation outside of middle Europe. It is one of a series of similar publications, covering various branches of science and technology, issued by the Office of Military Government for Germany, under the joint supervision of the French, British, and American FIAT Agencies.

The information is presented in the form of abstracts or terse reviews (in the German language) of the contents of a number of the standard journals in the fields mentioned above, together with a few textbooks, handbooks, dissertations, etc. It was prepared by a staff of German scientists under editorial supervision. Guidance into the extensive literature covered is facilitated by detailed subclassifications within each field; and each major section is followed by its own bibliography.

A TEXTBOOK OF HISTOLOGY. *Eighth Edition.*

By Harvey Ernest Jordan. D. Appleton-Century Company, New York and London. $7.50. xii + 690 pp.; ill. 1947.

This excellent textbook of histology has been quite extensively revised in its eighth edition. It is a pleasure to note that the section on Histologic Technic which in former editions occupied 100 pages, has been eliminated. There are at present a number of text books devoted purely to histologic technical and staining procedures, a fact which renders such an addition to a book on histology quite unnecessary. A number of colored illustrations has been added. The page length has been increased and the volume as a whole diminished in size by a reduction in the number of pages from that in earlier editions.

From the viewpoint of a pathologist, one may gladly note adequate descriptions of the juxtaglomerular apparatus of the kidney, the glomi of the skin, and the cells of Berger in the testicular and ovarian hila. On the other hand, one finds that too little emphasis has been placed upon cells and structures which are of extreme importance pathologically. In view of the effectiveness with which alloxan destroys the β cells of the islets of the pancreas, there need be no hesitanc

in ascribing to these cells the function of insulin production, and this should be appropriately emphasized. The enterochromaffin cells are described under the small intestine, whereas it should be indicated that they occur in the stomach and large bowel as well. Under sweat glands, the apocrine variety should be clearly distinguished from the ordinary eccrine types, whereas in the text the former are not even mentioned. A clear statement of the cells chiefly concerned in hematopoiesis in the bone marrow of normal individuals would be of advantage. After reading the chapter on bone marrow, the student must be left with the impression that the hemocytoblasts are the only ones which divide and mature to produce cells which appear in the peripheral blood. It would help in rounding out the discussion of endochondral bone formation to illustrate the principles of remodelling of bone as it occurs particularly at the diaphysial ends of long bones. Graphic reconstructions of the normal thyroid gland would help the student to understand its gross and microscopic alterations in disease.

One would like to see some of the newer, expanding knowledge of histochemistry incorporated within the textbook. To compensate, the physiological discussions in the text could be shortened, made more precise and, in some instances, such as the adrenal cortex, brought up to date. These statements need not, however, detract from the excellency of this textbook for student and graduate purposes.

C. A. KRAKOWER

AN OUTLINE MANUAL FOR THE STUDY OF HISTOLOGY. *Revised Edition.*

By Arthur J. Gatz. Burgess Publishing Company, Minneapolis. $1.75 (paper). iii + 80 pp. 1947.

This loose-leaf laboratory manual should be an excellent aid to the instructor in histology. It is basically a guide for the student so that he may obtain full information from the prepared set of slides. He is told what to look for and at the same time, by appropriate questions or statements, is given a complete and rounded picture of the structure and, to some extent, of the function of the tissue concerned. Untyped pages are interposed between the typed ones, permitting the student to draw what he sees under the microscope as well as to add his own notes.

C. A. KRAKOWER

CONGENITAL MALFORMATIONS OF THE HEART.

By Helen B. Taussig. The Commonwealth Fund, New York; Geoffrey Cumberlege, Oxford University Press, London. $10.00. xxxvi + 618 pp. + 46 plates; text ill. 1947.

The literature on cardiac malformation is extensive, the contributions of Keith (1909), Spitzer (1923), and Abbott (1936) illustrating how the many variations of the condition have been analyzed by workers whose approach and interests have differed widely. The volume under consideration is a welcome addition to this literature, being the most complete and accessible presentation of congenital cardiac malformation yet to appear.

The primary aim of the book is to facilitate the differential diagnosis of malformations of the heart and great vessels in the living patient. To this end the clinical data are collated with autopsy findings. The classification of the cases is clinical, division being made into those of inadequate oxygenation (persistent cyanosis, with life expectancy of about 18 months) and those with a life expectancy of many years (clinical syndrome not distinctive during infancy). The first part of the book covers general principles and phenomena common to all congenital heart malformations. The last part deals with therapeutic measures. An appendix tabulates the salient features of the cases. The index is adequate. The relationship of abnormal morphology to circulatory pattern is excellently presented in a series of 46 full-page plates in color. The 177 text figures further clarify the presentation, particularly interesting among them being 14 diagrams which compare the normal fetal circulatory pattern with that present in certain of the malformations.

Although clinical in approach, interest in this book will not be limited to the practicing physician. The illustrative material makes available a wealth of specimens collected over many years. Helen Taussig's classification of her material, based on the clinical picture and terminal morphology, has resulted in the wide dispersal through the book of cases traceable to abnormal growth during a continuous embryological process, such as, for example, the partitioning of the truncus arteriosus. Reclassification on the basis of developmental background and determination of the age of the embryo at which the malformation first became established would highly benefit students of embryology.

The author writes clearly. Accuracy is neatly balanced with stylized generalization in diagrammatic material. The organization and presentation are products of a skilled teacher. As stated in the author's preface, the book was written from the writer's experiences rather than from analysis of the literature, and the bibliography is therefore incomplete. Although a volume of limited coverage, this book bears the mark of years of patient, careful work and is a tribute to the purposeful specialization of one of the outstanding clinicians of our time.

F. N. LOW

THE NEOCORTEX OF MACACA MULATTA. *Illinois Monographs in the Medical Sciences, Volume V, Number 4.*

By Gerhardt Von Bonin and Percival Bailey. The University of Illinois, Urbana. $3.00 (paper). xii + 163 pp.; ill. 1947.

This splendid study of the cellular architecture of the cerebral cortex of the rhesus macaque monkey furnishes those neuroanatomists and physiologists who study primates with a thorough and presumably very useful work. Its scope includes almost the entire cortex (except the allocortex), and its methods involve the study and analysis of sections of 20 μ in thickness, cut in various planes (horizontal, frontal, parasagittal, and oblique) and stained with thionin. A superb series of 62 photographs of selected sections reproduces for the reader the raw material on which the study was based. The author's conclusions regarding the distribution of the distinct cellular areas are graphically incorporated in a colored "brain-map" that serves as frontispiece. The text is given over chiefly to a discussion of the cell arrangements shown in the sections, but there is in addition a chapter on the gross fissural patterns of the cortex, and some data are given on the growth of the brain and its weight relative to body weight in the macaque.

The cream of originality of this type of study was of course realized by Brodmann and by Campbell more than forty years ago, and to the former in particular every subsequent worker has been enormously indebted. The present work in many ways supplements and also corrects that of Brodmann, which was done in 1905 on a different but closely related species of monkey. The close agreement of the present study with that of Brodmann, which was achieved with less material prepared by less adequate histological methods, is at once a signal tribute to Brodmann and an immeasurable relief to everyone else.

The matter of terminology in such a study as this, where the results are translated into a useful code or map, is both a difficult and an important one. The authors have chosen to use the symbols of Economo rather than the more widely used numerals of Brodmann. They have done so because the former scientist has published the most detailed description of the human cortex, and they felt that the present study would have greatest anthropomorphic value if the macaque brain were similarly labelled. Economo's terminology has a certain logic not possessed by Brodmann's. For example, Economo has labelled contiguous areas of the frontal lobe FA, FB, FC, FD, whereas Brodmann's equivalent numbers are 4, 6, 32, 9. In addition, if one wishes to recognize two distinct strips within area FA, they may be tagged FA α and FA β. Thus the system is more flexible that Brodmann's, where the only recourse is to add another number that will of necessity be serially separated from the previous one. On the other hand, the terminology of Economo becomes cumbersome if piled too high, and it is difficult to use orally, in such designations for areas as FCBm and FCop. In any case Brodmann's numerals have become ingrained in the literature to an extent where the other system, regardless of its value, will be resisted by the majority of workers in the field.

The value of this work will rest upon its usefulness over a period of years, and any present judgment would be premature. It bears the marks, however, of an exceptionally capable piece of work.

JAMES M. SPRAGUE

HUMAN NEUROANATOMY. *Second Edition.*

By Oliver S. Strong and Adolph Elwyn. The Williams & Wilkins Company, Baltimore. $6.00. x + 442 pp.; ill. 1948.

Among the numerous new textbooks of neuroanatomy which have appeared during the past ten years this is perhaps the finest. It is comprehensive and is written clearly, in a manner which should be readily understandable to the college student who is making his his first acquaintance with the subject.

A series of eight more or less introductory chapters are presented before the detailed anatomy of the central nervous system is considered. Each of these supplies a useful background for the interpretation of more complex features to follow. The chapter on development is accurately written but is overloaded with a highly technical terminology, the interpretation of which must be difficult for those unfamiliar with the subject.

In this edition a new chapter on segmental and peripheral innervation has been added. It briefly recapitulates the gross anatomy of the peripheral nerves and their relation to dermatomic and myotomic areas, along with a brief description of the syndromes associated with the chief peripheral nerves. Terminating this chapter is an all too brief discussion of the regeneration of injured peripheral nerves. This section could well be expanded. In recent years reviews have appeared in various journals covering the principles of nervous regeneration and the potentialities and limitations of subsequent functional reintegration, but there is no adequate presentation of this important phase of practical neurology in a place readily accessible to the interested medical student. The chapter on the blood supply of the brain has been enlarged with the addition of useful color plates. This chapter is now as complete a presentation of the subject as can be found in any textbook on neuroanatomy.

To repeat: for its coverage of the field of neuroanatomy this textbook is recommended as one of the finest. It should be especially helpful to the medical student.

F. N. LOW

TEXTBOOK OF THE NERVOUS SYSTEM. *A Foundation for Clinical Neurology.*

By H. Chandler Elliott, with an Introduction by Wilder Penfield. J. B. Lippincott Company, Philadelphia, London, and Montreal. $8.00. xiv + 384 pp.; ill. 1947.

This book is one more of the growing number of elementary textbooks on the anatomy of the nervous system. It should be asked, in view of the present abundance of them already, whether the present volume offers anything new or whether it fills an important gap. It seems to do neither. It is essentially a presentation of neuroanatomy that the author has found useful in his teaching at the University of South Carolina, and which he believes will make a difficult subject more logical and interesting for the average student.

The author does write well, and he has included a sizable list of the experimental literature. The text is both alive and integrated. In contrast, the illustrations are very unsatisfactory. They consist of a series of simplified, stripped-down diagrams that the author refers to as the "basic brain," and of a small number of photographs. In the former, Elliott follows almost all writers on the nervous system in attempting to show the complexities of fiber tracts, connections, and nuclei by means of diagrammatic sketches. These, however, are simplified to a point where they frequently bear little or no resemblance to a real brain, and in addition they are poorly executed. The student will have difficulty in relating the "basic brain" to the actual material which he will see. The photographs are too few in number to help in his orientation, and many of them are taken of poor material and are not well reproduced.

JAMES M. SPRAGUE

FUNDAMENTALS OF NEUROLOGY.

By Ernest Gardner. W. B. Saunders Company, Philadelphia and London. $4.75. xii + 336 pp.; ill. 1947.

This is an integrated, well written, and eminently useful book. It aims at and achieves an enviable measure of simplicity, yet its title is not misleading, and in contrast to most so-called elementary texts it does not present a static picture. For a great difference exists between the presentation of "fundamentals" and of what is merely a simple story, and in the latter lies the pitfall of most writers who attempt to measure nature in teaspoons. Usually such efforts serve only to compress a broadly ramifying, vastly incomplete yet vastly challenging field into an absurd little pill that can be swallowed without chewing.

The author begins with several chapters on the gross and more obvious characters of the nervous system, and has added to the inevitable yet useful diagrams which adorn the teaching of neuroanatomy, a number of photographs of the material itself—nerves, spinal cord, and brain. A discussion of embryological development is followed by a chapter on the microscopic anatomy of the nervous system, again with photographs where possible. The remainder of the book presents the histology of the spinal cord, brain stem, cerebellum, and cerebrum from a functional point of view, based on experimental and, whenever possible, on clinical evidence also. Such a point of view is exemplified by the chapters on Excitation and Conduction, General Properties of the Reflex Arc, Structures Mediating Reception and Response, and the Control of Muscular Activity. In the discussions of the various divisions of the nervous system, the cerebral cortex is given more space and attention than any other part. General references to the literature are included in each chapter, and there is a glossary at the end of the book. The beginning medical student, as well as the general biologist who is unlearned in neurology, will find this little book interesting and very useful.

JAMES M. SPRAGUE

ANIMAL X-RAYS. *A Skeleton Key to Comparative Anatomy.*

By Brenda Putnam. G. P. Putnam's Sons, New York. $3.50. 96 pp.; ill. 1947.

This is a book about bones, the bones of vertebrate animals and the many variations of the central vertebrate scheme. Initialing the various joints for identification, the author carries the young reader through the vertebrate groups, showing how the variations in bone length, joint structure, and general flexibility all have their meaning in terms of adaptability, movement, posture, etc. The book, with excellent illustrations accompanied by a readable text, should give the young zoologist a keener insight and greater knowledge of the various animal forms and the evolutionary adaptations which fit animals for the lives they live. The book should likewise be of much value to those with artistic aspirations, for a knowledge of bone structure and movement is basic to any portrayal of outward form.

C. P. SWANSON

ANIMAL GROWTH AND DEVELOPMENT

LE FORZE CREATRICI DELL'UOVO. *Questioni Moderne d'Embriologia. Sapienza, Volume III.*

By Pasquale Pasquini. Vallerini, Pisa and Rome. L. 700 (paper). 333 pp. + 8 plates; text ill. 1948.

This little book is an eloquent and encouraging sign of the times. Addressed to the *colto publico* of Italy, it is a carefully non-technical exposition of the field of experimental embryology as it had developed before

the war. One is very happy to know that general interest in this field in Italy justified such a publication.

Pasquini has chosen classical themes for his chapters: a historical introduction; gametogenesis; normal embryogenesis, using the sea-urchin and amphibian eggs as models; germinal localization; organizing centers and induction in the amphibian egg; other aspects of embryonic induction; fields and gradients. In each chapter he has selected important material to present fully and clearly, accurately documented, and with excellent illustrations. The style is flowing, uncluttered by detail, yet extremely concrete. The reader is given a good deal of factual material in extremely palatable form. References to personalities add to the interest of the story as it is unfolded.

Readers on this side of the Atlantic might wish that the author had seen fit to include more details regarding the important work now under way in various Italian laboratories; but they must recall that the purpose of the book is to present the classical material of the subject to the layman, and not to advertise new directions for the scientific worker. Pasquini and the editors of the series *Sapienza* are to be congratulated on their enterprise and on the manner in which it has been fulfilled.

DOROTHEA RUDNICK

ANIMAL PHYSIOLOGY

COMPARATIVE PHYSIOLOGY.

By Bradley T. Scheer. John Wiley and Sons, New York; Chapman and Hall, London. $6.00. x + 563 pp.; ill. 1948.

During the past ten years the attention of physiologists has turned with ever increasing frequency toward the invertebrates. With this growing interest in the so-called "lower animals" there has come a realization that the examination and comparison of the different groups from a functional point of view may elucidate many of the basic problems of general physiology. As the study of the physiology of invertebrates has come of age, the need for a textbook suited for aspiring students of that field has grown. The appearance of the present volume is indeed timely. Scheer has attempted to fill this manifest need by writing a book which attempts to illustrate "by excerpts from the recent literature of comparative physiology the state of our knowledge in certain fields and, more important, the potentialities of the comparative method." In addition, the book was planned to be suitable as textbook for an advanced university course in comparative physiology.

After an introductory chapter which presents a summary of the physiological processes common to all animals, the author adopts a phylogenetic approach to his subject. Thus, with the exception of arthropods and vertebrates, discussion of which occupies four chapters, each major phylum is dealt with in a separate chapter. Within each chapter the topics are arranged on a functional basis. Hence, although the book as a whole is based on a phylogenetic plan, one may, by comparing the same function in each chapter, gain some idea of physiological changes and adaptations throughout the animal kingdom. In order to facilitate this, the author has arranged his discussion of functional units similarly in each chapter. In the section on the Annelida, for example, the order of treatment is: feeding, digestion, circulation, respiration, metabolism, excretion, osmoregulation, neuromuscular system, locomotion, central nervous system, sense organs, behavior, and summary.

There is, admittedly, a diversity of opinion as to whether any comparative subject in biology can be taught better by using a phylogenetic or a functional approach. Scheer has preferred the former, but in so doing he appears to have defeated one of the chief chief purposes of his book, in that the burden of comparison now rests largely on the shoulders of the reader. While one may consult, for example, the topic Vision in the chapter on the Mollusca and then again in the section on the vertebrates, he will find that points of functional similarity and dissimilarity have not been clearly and concisely stated. The comparisons of one phylum with another are not so well done as the comparisons of one vertebrate type with another within such a group.

Faced with the problem of choosing appropriate material from a vast array of facts, the author has done commendably, although one is frequently disappointed with the superficiality with which certain subjects have been treated. The material consulted has indeed been "organized into a series of sketches on the physiology of each of the major animal phyla," but most certainly these cannot be construed as representing the present state of our knowledge. One is piqued by such phrases as the following: "Extensive consideration of sense organs always involves much anatomical detail and has consequently been avoided in this book." It is true, nevertheless, that the faults are chiefly those of omission rather than commission, so that, as an introduction to the field of comparative physiology, this book should serve a useful purpose. It is well documented and indexed.

V. G. DETHIER

ANIMAL COLOUR CHANGES AND THEIR NEUROHUMOURS: *A Survey of Investigations 1910–1943.*

By George Howard Parker. Cambridge, at the University Press; Macmillan Company, New York. $6.50. x + 377 pp.; ill. 1948.

In this relatively small volume, G. H. Parker has brought together a tremendous number of data bearing on the phenomenon of color changes in cephalopods, crustaceans, and cold-blooded vertebrates. During the thirty-year period, 1910 to 1943, with which the present survey is primarily concerned, many important investigations were made in an effort to determine the mechanisms involved in bringing about the rearrangement of pigment within characteristic, highly specialized, color-bearing cells designated as chromatophores. It is to be expected that the physiological mechanism responsible for this spectacular and often rapid alteration in integumentary coloration is by no means simple, involving, as it does, reflex activities induced through the sense of sight, humoral substances, and, in some cases, the direct action of light on the skin.

In his discussion of the various concepts formulated in his field of research, Parker points out that the distinction which has frequently been made in the literature between nervous and humoral activation of chromatophores seems to be disappearing. In recent years it has become evident that the terminals of chromatic nerve-fibers excite their end-organs, the chromatophores, in much the same way that many other effector nerve-fibers appear to excite their responding organs, namely, through minute amounts of secreted substances (neurohumors) which are passed from the terminal to the effector. Hence, between the nerve ending and the chromatophore there appears to be the same relation as, for example, between the adrenal gland and the chromatophore, in that a substance produced by one activates the other. The one point of difference is that in the case of the nerve terminal the source is very near the color-cell, whereas in the case of the gland (adrenal) the source is far away from this cell. This difference of nearness or remoteness is not, in the author's opinion, in any real sense important, since in both instances a specific secreted substance, a neurohumor, is liberated, and upon reaching the chromatophore excites a response. It is readily seen that such a view is in strong contrast with the older conception of nervous stimulation by a nerve current.

Parker defines a neurohumor as a hormone produced by any type of nerve-cell (receptor or neurone) or by a gland controlled by neurones, and effective as an activator or inhibitor for other nerve-cells or for effectors. Included under the term "neurohumors" one finds a considerable number of substances such as adrenaline, intermedine, acetylcholine, sympathine, other products from chromatophoral nerve terminals, and the activating substance in the extract from the eye stalks or other secretory centers in crustaceans. Whether or not neurohumors will be found to have such a wide application as the above definition implies remains to be ascertained. It should, however, be said that the concept of neural humorism has contributed much to our understanding of the physiology of the chromatophores and has further brought the subject into line with the modern idea that chemical agents serve to transmit excitation at synapses and at the junctions of nerve endings with other types of effectors. The physiology of chromatophores is still an "invitingly open" field.

One of the most valuable features of this book is the extensive bibliography of over 1200 literature references. These are conveniently listed under three heads: (A) Surveys—including publications which present a general survey of the structure and functions of chromatophores; (B) Publications chiefly historical (prior to 1910); and (C) Publications from 1910 to 1943, inclusive. The text is fairly well illustrated.

M. RAWLES

MANUAL FOR LABORATORY WORK IN MAMMALIAN PHYSIOLOGY.

By Fred E. D'Amour and Frank R. Blood. The University of Chicago Press, Chicago. $2.75 (paper). 176 pp.; ill. 1948.

This is an unusual book, especially for days like these. It is a work-book about the laboratory rat as subject for a wide variety of physiological experiments. It should be of interest and great value to all laboratories engaged in physiological work. Colleges, medical schools, pharmaceutical houses, and all other research laboratories where such procedures are employed should know what this book has to offer. At a time when the cost and care of larger laboratory animals is prohibitively expensive, it offers a practical solution to the question of how to do good work using the laboratory rat. Not the least valuable of its contributions are the descriptions and pictures of apparatus to be used.

The list of experiments is most complete. Procedures for raising, handling, weighing, injecting, numbering, and anesthetizing rats are given, along with operative procedures for cannulation of the trachea, carotid artery, and jugular vein. There are six experiments on blood, ranging from blood volume to measurement of the freezing point of blood; twelve experiments on the heart and circulation, including studies of blood pressure, blood flow determinations, circulation times, carotid sinus experiments, and observations on minute vessels; six experiments on respiration, including studies of respiratory rate, tidal air and minute volume measurements, Hering Breuer reflexes, and O_2 consumption, R. Q. and BMR determinations. Experiments on digestion and metabolism include ones on glucose absorption, alloxan diabetes, gastric secretion, and intestinal motility. Excretion experiments on saline diuresis and bladder contraction time are given. There are seven experiments on the nervous system, including ones on nerve-muscle relations, energy of muscular

contraction, the Bell-Magendie Law, motor areas in the cerebral cortex, and the autonomic nervous system. There are seven experiments on various aspects of endocrine activity (adrenalectomy and cortin; thyroidectomy and thyroxin; pregnancy tests; ovariectomy and estrogens; gonadotrophic hormones and castration and testosterone). An experiment on antibody formation ends the list.

There can be no doubt that modifications of many of the ingenious and detailed procedures described here will be made as workers with other experience and facilities use them. But this book provides proof that a wide range of instructive experiments can be done simply and on inexpensive animals, without the necessity for large animal quarters, and with the employment of standard or easily improvised equipment.

S. R. M. REYNOLDS

LABORATORY MANUAL FOR EXPERIMENTAL PHYSIOLOGY. (*Fifth Edition.*)

By H. D. Bergman and E. A. Hewitt. Burgess Publishing Company, Minneapolis. $1.75 (paper). iii + 116 pp. 1946.

This is another manual which is probably admirably suited to meet the educational requirements and responsibilities of its authors. It is intended to serve as a reference as well as a laboratory guide and notebook. The course begins with a consideration of blood and ends with the Special Senses. It contains some physical chemistry, nutrition, and general physiology, besides the commoner physiological experiments carried out with mammals and amphibian tissues. The manual seems to show that much effort has been spent on its production. It indicates a thorough and sound course of teaching. This book may satisfy one's curiosity as to how teaching is done elsewhere. Laboratory manuals can seldom meet the needs of other institutions, but a teacher will welcome the opportunity to glean new ideas and devices for effective teaching.

CHANDLER MCC. BROOKS

LABORATORY EXPERIMENTS IN PHYSIOLOGY. *Fourth Edition.*

By W. D. Zoethout. The C. V. Mosby Company, St. Louis. $3.00. 263 pp.; ill. 1948.

This laboratory guide does not attempt to usurp the function of textbooks by publishing long detailed explanations and sample charts and graphs of obtainable results. The exercises given deal precisely with the apparatus needed and the experimental procedures to be followed. The book is divided into two parts. Part I contains eleven chapters and some 152 laboratory exercises. The subjects covered in these chapters are: apparatus, general physiology, muscle physiology of nerve, central nervous system, circulation, respiration, sense organs, the alimentary canal, and urine and sweat secretion. Part II deals with the rudiments of physiological chemistry and contains 100 exercises covering the chemistry of carbohydrates, fats, proteins, digestion, urine, and various body substances and food materials. The exercises are very short and simple. For beginning students of college or university level they would be quite suitable, but many are too elementary for graduate students. The book contains no experiments on metabolism. Many of the short exercises could, it seems, be combined into more inclusive single experiments. One does not obtain a very good grasp of the interrelationships and the function of the body as a whole from such a series of superficial contacts. This little book will serve as a very valuable aid to many who teach introductory courses in physiology.

CHANDLER MCC. BROOKS

A LABORATORY MANUAL OF GENERAL PHYSIOLOGY. *Revised Edition.*

By Nelle A. Hartwig. Burgess Publishing Company, Minneapolis. $1.50 (paper). ii + 69 pp. 1947.

This manual was designed for use in an elementary course in physiology for students of pharmacy, but it is thought by the author that it might be used in similar courses for students of home economics, nursing, and the arts and sciences. It is intended for a 2-quarter course of 4 credit hours each. The manual is divided into fifteen major sections, each of which is subdivided into exercises. The titles of the subdivisions suggest a rather peculiar concept of the subject matter of general physiology. The exercises propose some very simple experimental procedures, and then many questions are asked. Many of the suggested activities seem to have very little connection with physiology, but it is quite possible that the manual meets the need for which it was intended. Certainly not much previous training is expected of the student.

CHANDLER MCC. BROOKS

THE PHYSIOLOGY OF DOMESTIC ANIMALS. *Sixth Edition.*

By H. H. Dukes; with a chapter on The Physicochemical Basis of Physiological Phenomena by E. A. Hewitt; and a part on The Endocrine Organs, Reproduction, and Growth by S. A. Asdell. Comstock Publishing Company, Ithaca, New York. $7.00. xiv + 817 pp.; ill. 1947.

This is an enlarged and revised edition of a standard textbook, now firmly established for teaching physi-

ology in schools of veterinary medicine and animal husbandry. Its pattern remains the same. It deals systematically and comprehensively with the subject in an elementary style. It is replete with useful data of a comparative nature, especially with respect to digestion and absorption, heat regulation, and reproduction. As such, it is a useful reference for students of medicine who have much to gain by adopting a comparative point of view.

The basic fault of the treatment of the subject used in this book, as judged by one trained in physiology applied to medicine, is that it consistently fails to put in relief those comparative functions in the body which are peculiarly suited to the requirements of different domestic animals. For example, the relationship between muscle mass and working power defined by the Rev. Samuel Haughton (*Principles of Animal Mechanics*, 1873) must apply with special force to various domestic animals. Similarly, the cardiovascular, respiratory reserve, and other factors that make a winning race horse different from a slower steed offer tantalizing problems to the physiologist. It is clear from the account of heat-loss mechanisms here that much remains to be learned concerning these in different types of animals. The section by Asdell on Reproduction is accurate and well done, in a basic sense. One gains the impression, however, that the comparative mechanisms are not sufficiently treated for students of animal husbandry. Particularly disappointing, in view of the basic work of Grosser, to which Mossman has added his now classic contribution, is the statement that a placental classification of mammals is difficult to make.

S. R. M. Reynolds

Human Physiology. *Third Edition.*
By F. R. Winton and L. E. Bayliss. The Blakiston Company, Philadelphia and Toronto. $7.00. xvi + 592 pp. + 1 plate; text ill. 1948.

The authors of this volume have performed a most useful service. They have prepared an integrated text which is short yet very complete and comprehensive in many aspects of physiology. It should fulfill a needed role for all who require or desire a coherent picture of the whole subject. The authors write that "medical students are expected to learn too much and think too little, and the authors have therefore prevented the book from growing out of its shape as one of the smaller textbooks of Human Physiology." It is, one may add, one of the best.

In the preparation of this book, the authors have secured the assistance of many of the leading active English physiologists, each writing on his own specialty. In order to prevent the text from being unbalanced, however, Winton and Bayliss have exercised judicious editorial supervision with respect to content and emphasis. The contributors, with their contributions, include Pickering (circulation), Mackay (respiration), Gregory (digestion), Smyth (Sheffield), Young (carbohydrate metabolism and endocrine glands), Newton (reproduction and endocrine glands), Eggleton (muscle chemistry), Whitteridge (nerve, special reflex system, localizations in the central nervous system), Feldberg (autonomic system and chemical transmission), Lythgoe (eye), and Rawden-Smith (ear). The authors are themselves responsible for the other sections, which deal with blood and other body fluids, excretion, and muscle physiology, as well as other parts scattered throughout the text. The first chapter is entitled Physiological Activity. It orients the reader with respect to the range of coordinated bodily activities involved in muscular exercise, physiological equilibria, and fatigue.

In any textbook of physiology, particularly a collaborative effort which maintains relative brevity, it is inevitable that there will be some aspects of the subject that are inadequately treated. A different reviewer would note different things. To this one it seemed that the parts relating to peripheral circulation have an inadequate discussion of the reciprocal and coordinated control of different peripheral vascular beds, the effect of branching, and so forth. Similarly, the discussion of seasonal variation in the functioning of the minute vessels and their adjustments with age, topography, and posture would render a traditional treatment of the subject enlightening. As much may be said for certain other sections of the book. For example, one will not grasp from this textbook an appreciation of those mechanisms whereby the uterus becomes adapted to the growing products of conception during pregnancy. But to insist upon and extend such criticisms would detract from the success which Winton and Bayliss have actually achieved in preparing a comprehensive text that is also brief. To supplement his reading a medical student or teacher can doubtless resort to one of the larger standard textbooks for reference purposes.

S. R. M. Reynolds

Human Physiology Syllabus.
By J. A. Dye. Comstock Publishing Company, Ithaca. $3.00 (paper). iv + 152 pp.; ill. 1947.

It seems that there is very little to be said about such a work. Unquestionably, the subject matter of physiology is rather thoroughly dealt with here and the syllabus probably meets the aims of the author's course quite admirably. This one begins with a consideration of Blood, Circulation, Respiration, etc., and ends with Nerve, Muscle, and the Central Nervous System. Many courses in physiology begin with a consideration of nerve and muscle, but the reviewer's only conviction about that is that a teacher should be

permitted to begin as and where he pleases. The mixture of information and promise given in the syllabus betokens a high ambition. The syllabus so closely approaches a textbook in size, however, that one rather wonders why the author didn't just amplify things a bit more and call it that. In places it is a bit too condensed, and one is left wondering about classification—why should talking and singing be classified as protective respiratory reflexes? All in all, this is a very impressive syllabus and should serve to inform others of the subject matter of the Physiology Course at Ithaca.

CHANDLER McC. BROOKS

HUMAN PHYSIOLOGY.

By Kenneth Walker. Penguin Books, West Drayton, Middlesex. 1s. 6d. (paper). 169 pp. + 2 plates; text ill. 1948.

This is a brief, pocket-sized edition of a popularized version of the subject of human physiology. The author is a London consulting surgeon and the author of physiological and medical treatises. The book is written for the purpose of allaying fears on the part of laymen—since anxiety is, according to the author, the commonest symptom seen in the consulting room. The essential core of human physiology is covered quickly and well. The book is not critical, and it is not always accurate and up to date. That is of little consequence, however, to those who are most likely to read this booklet and benefit by it. After all, it is a pocket-sized edition to be purchased for the equivalent of a quarter dollar in the numerous book shops that serve such a large proportion of the English reading public.

S. R. M. REYNOLDS

THE 1947 YEAR BOOK OF ENDOCRINOLOGY, METABOLISM AND NUTRITION.

Edited by Willard O. Thompson and Tom D. Spies. The Year Book Publishers, Chicago. $3.75. 575 pp.; ill. 1948.

Annual volumes in many scientific fields have become a necessity owing to the inability of even the most assiduous student of technical literature to read everything that is published which has a bearing on his specialty. The present volume is the second under the title. It will be welcomed by progressive physicians, investigators, and all technically trained people in every field of science who wish to follow the progress of research in biochemistry.

Even the studious specialist profits by reflection on well prepared comments on those scientific papers which outstanding investigators select as the most significant contributions of the year. In the present volume, 293 pages are devoted to approximately as many individual papers relating to studies of the pituitary, thyroid, parathyroids, adrenals, testes and ovaries. Metabolism and nutrition reviews are given 261 pages. These cover pancreas and liver, alimentary tract, hemopoietic system, cardiovascular system, the brain and nervous system, genito-urinary system, dermal, muscular, and skeletal systems, malnutrition, and therapy.

An important feature of this book is the brief editorial comment which follows, in most cases, the abstract of the original contribution. These add to the value of the volume.

E. V. McCOLLUM

RECENT PROGRESS IN HORMONE RESEARCH. *The Proceedings of the Laurentian Hormone Conference. Volume II.*

Edited by Gregory Pincus; Committee on Arrangements: R. W. Bates, R. D. H. Heard, and G. Pincus. Academic Press, New York. $8.00. vi + 427 pp.; ill. 1948.

The articles in this volume differ somewhat from the usual review in that the subject matter was first given orally, that the authors are particularly concerned with their own current work, and that original material comes out in the text and in the very readable discussions that follow most of the presentations. As in the first symposium, range of interest is wide. Fourteen articles, grouped into five sections, cover physical methods in hormone research, pituitary control and activity, hormone metabolism, hormonal regulation of metabolism, and aspects of clinical endocrinology. Fresh viewpoints are particularly notable in the contribution of Petersen on lactation in the larger animals, and in Anderson and Long's beautiful perfusion experiments with the pancreas. Richter discusses the toxic thioureas, originally developed as rodenticides, with an entertaining aside on how to catch (and keep) a wild rat.

The topicality of a conference seems to demand early publication—even at the expense of a format as handsome as this one. It may be pointed out that, as this meeting was held in September, 1946, we are at the present date still two conferences behind. A further complaint—against the tendency to duplicate reviews in related publications—and one not negligible, in view of the insidiously rising cost of such publications—is addressed to no one in particular.

H. R. CATCHPOLE

PSYCHO-PHYSIOLOGIE DES GLANDES ENDOCRINES ET DU SYSTÈME NEURO-VÉGÉTATIF. *Nouveau Traité de Psychologie, Tome Septième, Livre II.*

By F. Caridroit. Presses Universitaires de France, Paris. 100 fr. (paper). iv + 112 pp.; ill. 1946.

Ignoring the quotation of references now superseded (or discredited), this will be found an interesting, brief account of the psychical manifestations associated with the endocrines, both normally and in dysfunction. That of the autonomic system appears to be largely a verbal exercise ranging around the various possible "tonuses" that may be imagined. The author's conclusions are conservative and point to the fact that we know next to nothing of the processes affected by the hormones, either in their target organs or in their wider relationships with the central nervous system.

H. R. CATCHPOLE

THE SIGNIFICANCE OF THE EXTRACELLULAR FLUID IN CLINICAL MEDICINE. *The Ernest A. Sommer Memorial Lectures Delivered at the University of Oregon Medical School, June 6, 7 and 8, 1946.*

By L. H. Newburgh. J. W. Edwards, Ann Arbor. $1.75 (paper). 64 pp.; ill. 1946.

This is one of a series of lectures designed to emphasize the advances in physiology and pathology as a basis for improving the practice of medicine. The purpose of this particular lecture was to discuss the relations between abnormalities of extracellular fluid and a number of diseases. The various fluid reservoirs of the body are described, and the composition of these body fluids is given. Very brief accounts of the respiratory and renal regulation of extracellular fluid pH and composition are also given. Following this description of the nature of the extracellular fluid and the normal regulatory mechanisms, the clinical significance of studies of this fluid is elucidated. The abnormalities of the extracellular fluid in a variety of pathological states are described, together with the effects of a reduction of body sodium, and a study of edema, dehydration, water balance, and the control of the specific gravity of urine. Water requirements in nephritis are given, and certain low sodium diets are listed. This is a very instructive book, and also one easily read. The author is to be congratulated on the clarity of this presentation.

CHANDLER McC. BROOKS

CHEMICAL ANATOMY, PHYSIOLOGY AND PATHOLOGY OF EXTRACELLULAR FLUID. *A Lecture Syllabus. Fifth Edition.*

By James L. Gamble. Harvard University Press, Cambridge. (paper). 160 pp.; ill. 1947.

The fifth edition of this highly valuable lecture syllabus (see QRB 20: 178. 1945) includes five additional charts, raising the total to 52. It is scarcely necessary to say that the text has been brought up to date.

PHYSIOLOGY OF MUSCULAR ACTIVITY. *Third Edition.*

By Edward C. Schneider and Peter V. Karpovich. W. B. Saunders Company, Philadelphia and London. $3.75. viii + 346 pp.; ill. 1948.

This edition marks a turning point in the life of this well-known book. A new author appears beside Professor Schneider and new work makes it a worthy successor to the earlier editions. While the entire text has been rewritten, much new material is included in the chapter on Work, Energy and Mechanical Efficiency; and sections on Body Types and Posture have been added, along with chapters on Activities for Convalescents and Ergogenic Aids. All of these reflect the interests of the junior author.

The approach to each phase of the subject is from the basic approach of fundamental physiology, leading over into its special applications with respect to exercise, physical fitness, and physical education. Admittedly, for those who desire a full, accurate, and comprehensive understanding of the relevant physiology, other sources and authors must be consulted. There are, moreover, some noteworthy omissions of matters one would expect to find discussed in a textbook on this subject. There is no adequate description of the role of anaerobic metabolism in energy production by the body, nor does one find any reference to the brilliant work of Szent-Györgyi and his associates on the probable roles of actin and mysin in muscular contraction. Similarly, in discussing the role of gaseous interchange in exercise, one finds no reference to the enzyme carbonic anhydrase.

The sanity of the approach which these authors take to the subject of fatigue and physical fitness is refreshing. The sentence which reads, "The purpose of physical education is not to win games for one's alma mater, but to help each person to attain an optimum level of development predetermined by his structural potentialities," is reminiscent of the wartime attitude of Karpovich who, when drawing up physical training programs for flying personnel in the AAF, said that flyers had to *fly* airplanes—not *carry* them.

S. R. M. REYNOLDS

MUSCULAR CONTRACTION. *Annals of The New York Academy of Sciences, Volume XLVII, Article 6.*

By Alexander Sandow, R. S. Bear, Ernst Fischer, A.

S. Gilson, Jr., Eugene Guth, C. E. Hall, M. A. Jakus, S. W. Kuffler, Otto Meyerhof, Severo Ochoa, Robert W. Ramsey, F. O. Schmitt, G. M. Schoepfle, Shih-Chang Shen, H. Burr Steinbach, and S. M. Walker. The New York Academy of Sciences, New York. $3.00 (paper). Pp. 665–930 + 9 plates; text ill. 1947.

This publication is a series of papers read at a Conference on Muscular Contraction held by the Sections of Biology, and Physics and Chemistry of the New York Academy of Sciences, February 15 and 16, 1946. It is a notable publication for a number of reasons. It presents a perspective of the subject which crosses the border zones between several disciplines, and it offers variety and considerable depth within the different disciplines.

The publication is divided logically into four parts: I, Dynamics; II, Ultrastructure; III, Chemistry; IV, Mechanic Chemical Coupling. Alexander Sandow deserves great credit for his organization and planning of the Conference which resulted in this publication. The individual authors present their subjects with great care and thoroughness, and some achieve a simplicity of statement and forceful logic which render them distinctive as contributions to a symposium that will be read by physiologists generally. Among these are articles by Ramsey (Dynamics of Single Muscle Fibers), Schmitt, Bear, Hall and Jakus (Electron Microscope and X-ray Diffraction Studies of Muscle Structure), Meyerhof (The Main Chemical Phases of the Recovery of Muscle), and Shen (The Interaction of Myosin and Adenosine Triphosphate). Others deal most competently in a highly technical way with their subjects, and only two are of a standard not equal to the rest, inasmuch as they consist of reports of numerous data and facts without an interpretation of them into a broad or general concept of muscular contraction.

The recent important work of Szent-Györgyi on actomyosin was not generally known to American workers at the time this symposium was held. There are a number of references to preliminary notes by Szent-Györgyi, and Shen presents many aspects of this work. It is probable, however, that many viewpoints contained in the book under review would have been modified or simplified had the full import of Szent-Györgyi's Continuum Theory (see, *Chemistry of Muscular Contraction*, reviewed QRB 23: 75; and *The Nature of Life*, both by Szent-Györgyi, 1948) been considered from many angles by the contributors to this symposium.

S. R. M. REYNOLDS

MUSCLE TESTING: *Techniques of Manual Examination. By Lucille Daniels, Marian Williams, and Catherine Worthingham. Designed and illustrated by Harold Black. W. B. Saunders Company, Philadelphia and London.* $2.50 (paper). 189 pp. 1946.

This booklet describes manual muscle tests and the test positions for evaluating muscle strength. It is well illustrated with line drawings. Along with the description of the tests, the authors have outlined "range of motion," "factors limiting motion," "fixation," and have given the origin, insertion, and action of the prime mover in the group-action test. All of this information is pertinent to the subject of muscle testing. The material is presented in a concise manner, and is especially suitable for quick reference. The diagrams are very clear, and in most instances accurately illustrate the test as presented. In various instances, however, either text or diagram or both are technically faulty.

The anatomical action of a muscle and the test movement will not be identical unless the position of the body is such that the muscle will be called on to function. The test (p. 69) in which the tensor fascia femoris is supposed to be the prime mover is in reality a test in which the posterior gluteus medius and minimus are prime movers. By internally rotating the leg in the direct side-lying position, the tensor is rotated out of position to lift against gravity. If the pelvis were rolled backward (to a position midway between back and side-lying) or the patient were back-lying, then the tensor would be brought into strong action to maintain internal rotation, abduction, and flexion, which are the anatomical actions of this muscle.

The illustration of the range of motion in the hip internal rotation test (p. 60) leads one to assume that the range of motion which one has in the sitting position is present in the back-lying position with the knee bent over the end of the table, and the lumbar spine flat on the table. Such is not the case unless the hip is more relaxed than normal. In an average individual, internal rotation of the hip is practically locked past the perpendicular position of the lower leg in the supine position described above.

The middle trapezius is named as prime mover in the scapular adduction test (p. 110). With no attachment along the vertebral border of the scapula, but only along the spine, it is quite misleading to represent the middle trapezius as prime mover in the straight adduction motion, as illustrated by the "range of motion" drawing. Actually, the inferior angle rotates outward as the middle trapezius adducts the upper part of the scapula.

In the scapular adduction and depression test (p. 114) the muscle drawing and the test movement are accurately described, but the scapula does not move in the direction illustrated by the "range of motion" drawing.

In the trunk flexion test (p. 27) two of the illustra-

tions show the hip flexor action in the abdominal muscle test by the fact that the lumbar spine and sacrum are shown lifted from the table in flexion of the pelvis on the thighs. The verbal description under "range of motion" is accurate, but the drawing does not follow the description accurately. Tests of group action as described in this manual must therefore not be considered as accurate tests for the prime mover named in every instance. This booklet will be found useful by those who choose to test muscles according to group action for the purpose of functional evaluation of strength, but is of little value for those who seek to do individual muscle testing for the purpose of neuromuscular diagnosis.

HENRY O. KENDALL

THE INTEGRATIVE ACTION OF THE NERVOUS SYSTEM. *By Charles Sherrington. Yale University Press, New Haven.* $6.00. xxvi + 433 pp. + 1 plate; text ill. [1906]; 1947.

Thanks to the Physiological Society, biologists may now own a copy of Sherrington's classic of 1906, out of print for a generation. The text has been reset and reprinted in its entirety, and unchanged except for the correction of misprints and minor errors. All figures were redrawn, since the old blocks were worn out. A signed photograph of the author, a curriculum vitae, and a bibliography have been added to enhance the edition, and, best of all, Sherrington has himself written a new Foreword for it. These twelve pages are an apologia in reply to the criticism that Sherrington's concern in this volume almost wholly with reflex behavior led him to ignore the higher levels of psychological integration. Sherrington replies that the choice of reflex action for study was for practical laboratory reasons, for the very reason, in fact, that it is free of the complications of the psyche, with its "urges" and "drives," and free even of such complexities as occur in autochthonous, rhythmic activities like breathing. Sherrington goes on to discuss briefly the great problem of the integration of the two incommensurables, body and mind, the physical and the psychical. Sherrington ventures no final answer, of course, any more than the humblest physiologist—but his hinted preference for a dualistic solution is worthy of note.

DOSAGE BIOLOGIQUE ET CONTRÔLE DES MÉDICAMENTS. *Bibliothèque Scientifique Belge, Section Biologique. By Jean La Barre and Jacques Thomas. Masson et Cie., Paris.* 220 fr. (paper). 142 pp.; ill. 1947.

This 140-page monograph deals with the biological standardization of the more important pharmaceutical and biological preparations. The author discusses those instances where biological tests are accepted as superior to chemical determinations. Bioassay is used for the determination and standardization of potency and also of toxicity and tolerance. Among the latter toxicity tests for arsenicals are given in detail. The author then describes the customary procedures for the bioassay of endocrine preparations (thyroid, suprarenal, posterior pituitary, insulin, and male and female sex hormones), for the most important vitamins, and also for digitalis, ergot, and anthelminthics, with European and American standard procedures with special reference to the Belgian Pharmacopoeia. Many of the methods are given in sufficient detail that the reader could perform them without having to consult further reference works.

GERTRUDE D. MAENGWYN-DAVIES

THE SALICYLATES. *A Critical Bibliographic Review. Monographs of the Institute for the Study of Analgesic and Sedative Drugs. II. By Martin Gross and Leon A. Greenberg; with an Introduction by Howard W. Haggard. Hillhouse Press, New Haven.* $6.00. xviii + 380 pp.; ill. 1948.

The extensive use of the class of medicinal agents known as salicylates has given rise to a vast scientific literature. The authors of this volume have reviewed the pertinent literature in all languages and have prepared a bibliography of over 4000 titles. This review is the second in a series on analgesic and sedative drugs. The first volume which appeared in 1946 was a monograph on acetanilid. The work on the salicylates deals with a group of chemically and pharmacologically related compounds. The use of derivatives of salicylic acid in the treatment of rheumatic fever and as analgesics in medical practice is well established. In proprietary pharmaceutical preparations the salicylates are consumed in tremendous quantities, chiefly as acetylsalicylic acid. The authors state that the average production in the United States in the period 1935 to 1944 was more than six million pounds of acetylsalicylic acid per year. These compounds are thus of considerable toxicological interest. The literature on both the pharmacology and toxicology of the salicylates has been reviewed in detail.

The seven chapters of the book cover the following subjects: therapeutic uses; salicylate poisoning in the United States, with case reports and the question of addiction or habituation; historical background—the discovery of the medicinal properties of the salicylates; the fate of the salicylates in the body, a review of

analytical methods that will be useful to workers in this field. Throughout the text the results of published work are presented in tabular and chart form.

It is unfortunate that the four structural formulas given for the salicylate compounds on p. 8 are incorrect. The tremendous alphabetical biliography would have been rendered more legible and more usable had the columns been indented so as to make authors' names stand out. These are minor points and detract but little from the general excellence of the volume.

C. JELLEFF CARR

TRAVAUX RÉCENTS SUR LES TOXIQUES DE GUERRE: LE BAL (*British Anti-Lewisite*). *Actualités Biochimiques, Number 8.*

By Z. M. Bacq. Éditions Desoer, Liège; Masson & Cie., Paris. 60 fr. (paper). 48 pp.; ill. 1947.

This small booklet contains a collection and abstraction of work on poison gases, giving data found by American and British authors, and bringing up to date our knowledge of the biochemical and pharmacological experimentation in this field that was undertaken by Belgian workers during and after the war.

The studies on British Anti-Lewisite are most fully described. The tables and figures in this pamphlet clearly illustrate the pharmacologic action of the vesicants which attack the SH-groups of proteins. Peacetime medical applications are reported and references given. The booklet contains an excellent bibliography of 60 references. It should be highly interesting to American readers. It is well written, clear, and informative.

GERTRUDE D. MAENGWYN-DAVIES

L'INTOXICATION PAR L'ALCOOL ÉTHYLIQUE. *Pharmacologie, Toxicologie et Médecine Légale. Médecine et Biologie, Number 2.*

By H. Casier and A. L. Delaunois, with preface by C. Heymans; edited by Marcel Florkin. Editions Desoer, Liège: Masson & Cie., Paris. 100 fr. (paper). 185 pp. + 1 chart; text ill. 1947.

This is a scientific report on the pharmacology and toxicology of ethyl alcohol, with charts, statistics, and an extensive bibliography. It is quite evident that the authors are concerned about alcohol and intoxication, considering it of national importance (in Belgium also), because of the very direct bearing it has on motor vehicle and other avoidable serious accidents. There is, therefore, some emphasis on tests for alcohol concentration in the blood, serological analyses being evaluated as both useful and necessary in medical legal cases.

Chapter X surveys thoroughly the effects of other pharmacologic substances (hypnotics, narcotics, analgesics, vitamins, insulin, etc.) on ethyl alcohol after ingestion; and there is also an able, though brief, discussion of the factors of individual variation in alcohol tolerance, such as fatigue, mood, and so forth.

The toxic quality of alcohol itself—aside from nutritional depletion, varying avitaminotic and psychological conditions—is unequivocally stressed by the well-supported scientific conclusion that "while the presence of 1 g. °/₀₀ alcohol in the blood constitutes a real danger in motor vehicle driving (autos, buses, trains), even slight amounts of alcohol cause potential hazard changes in the physical and nervous motor system coordination."

VICTORIA CRANFORD

ANIMAL NUTRITION

A TEXTBOOK OF DIETETICS. *Second Edition.*

By L. S. P. Davidson and Ian A. Anderson, with Diet Sheets constructed by Mary E. Thomson and a Foreword by Sir John Boyd Orr. Paul B. Hoeber, Medical Book Department of Harper and Brothers, New York and London. $6.00. xx + 517 pp.; ill. [No date].

This book is directed primarily to students of medicine and general practitioners. The authors express the belief that the family doctor, properly instructed, can and should play the chief part in the education of the public on matters of diet and nutrition. The authors are professor of medicine and lecturer on clinical chemistry, respectively, at the University of Edinburgh and the University of Aberdeen. This reviewer does not share the opinion of the authors that the family doctor can or should be an educator in nutrition for the general public.

The book is well written and is a reliable source of information about many aspects of food and nutrition. Twenty chapters include: a general survey; the physiology of nutrition; diet in periods of physiological stress; nutrition and diet in war-time; dietetic treatment for diabetes mellitus, diseases of the alimentary tract, the liver and biliary tract, the kidney and urinary tract, gout and rheumatism, obesity and excessive leanness, the cardiovascular system, infectious diseases, and the anemias; and special feeding methods. Part V includes tables of food analyses, and for construction of individual and group diets, recipes, tables, and thirty-eight diet sheets relating to various normal and pathological conditions. A novel feature of the book is the inclusion after the discussion of each vitamin of a list of proprietary vitamin preparations with their declared potencies. Most of these have trade names common in England but not familiar to Americans.

E. V. MCCOLLUM

THE CHEMICAL COMPOSITION OF FOODS. *Second Revised Edition.*

By R. A. McCance and E. M. Widdowson. Chemical Publishing Company, Brooklyn, New York. $3.75. iv + 156 pp. 1947.

This revised edition of tables of the chemical composition of foods comes from the Department of Medicine of the University of Cambridge. The correction of mistakes in the former edition has been made with care. Wherever published values showed wide discrepancies, new analyses have been undertaken. "Every calculation and figure has been checked by at least two persons."

The classification of foods, of a practical rather than scientific character, is into the following groups: cereals and cereal foods; dairy products; meat, poultry, and game; fish; fruit; nuts; vegetables; sugar, preserves, and sweetmeats; beverages; beers; condiments; vegetable fats; cakes and pastries; puddings; meat and fish dishes; egg and cheese dishes; sauces and soups; vegetable dishes. There are two sets of tables, giving the composition per 100 g. and per oz., respectively. Many, if not most, of the foods are found in the American diet, so that the tables should find great use by all who need a reference work on the composition of common foods.

BENTLEY GLASS

FOODS: *Their Values and Management.*

By Henry C. Sherman. Columbia University Press, New York. $3.25. x + 221 pp. 1946.

This book is essentially a companion to *The Science of Nutrition*, being planned to supplement the latter with a popular account of food values and the best ways to coordinate the economic and nutritional phases of food management. The foods are grouped into ten food-groups: grain crops; mature legumes and nuts; potatoes and sweet potatoes; green and yellow vegetables; citrus fruits and tomatoes; other fruits and vegetables; milk and its products (except butter); meats, fish, poultry, eggs; food fats; sugar and sweets. Following an introductory chapter on food supply in the modern world, there is a chapter on each one of these food groups. The place of each food group in the individual, family, and national dietary is compared with its contribution to energy, protein, mineral, and vitamin needs. The distribution and conservation of vitamin values and the amino acid balance receive special consideration. While the book seems to be written primarily for housewife, dietitian, and home economics student, biologists who are interested in problems of nutrition will find it useful. The bibliography includes more than 500 titles, and there is a good index.

BENTLEY GLASS

DIET AND PERSONALITY.

By L. Jean Bogert. Garden City Publishing Company, Garden City, New York. $2.00. x + 181 pp. [1934]; 1947.

It is a relief to a harried reviewer to run across so good a writer as Jean Bogert. Her topic is the relation of nutrition to constitutional types. She writes in a breezy but competent way of all sorts of nutritional problems, from susceptibility to infections to indigestion and constipation. She is no faddist. There are signs that the book has been revised and brought up to date, although this edition passes as a reprint rather than a new edition. For a book fourteen years old (see QRB 9: 485. 1934), *Diet and Personality* is surprisingly fresh and worth-while.

NUTRITIONAL DISORDERS OF THE NERVOUS SYSTEM.

By John D. Spillane, with a foreword by George Riddoch. The Williams & Wilkins Company, Baltimore. $5.00. xvi + 280 pp. + 32 plates; text ill. 1947.

The author was Lieutenant-Colonel in the British Army during World War II and had a broad experience in prison camps. While serving in the army as Advisor in Neurology, Middle East Command, he investigated among German and Italian prisoners of war and Polish refugees a number of those syndromes which later were found also to have affected a considerable number of captives of various nationalities in Japanese prisons.

The book covers, rather briefly, our present knowledge of all known nutritional diseases attributable to deficiency of one or more of the water-soluble vitamins. The difficulties of etiological assessment in terms of vitamins, qualitative and quantitative food deficiencies, and accumulation of toxic metabolites are discussed. The thirteen chapters are devoted to: The Vitamin B Complex; Pellagra; Beriberi; Polyneuritis; Wernicke's Encephalopathy; Nicotinic Acid Deficiency; Encephalopathy and Allied States; Subacute Combined Degeneration of the Spinal Cord; Nutritional Neuropathy in Warm Climates; Nutritional Neuropathy in War-time; the author's personal experiences (two chapters); Gastrointestinal Tract and Nutritional Neuropathy; and General Conclusions. A well selected bibliography of the more important scientific papers on which the chapters are based is appended to each chapter. Clinicians concerned with nervous disorders and mental diseases, physiologists, and students of nutrition will find much of interest in this volume.

E. V. MCCOLLUM

THE BIOLOGICAL STANDARDISATION OF THE VITAMINS. *Second Edition.*

By Katharine H. Coward. The Williams & Wilkins Company, Baltimore. $5.00. viii + 224 pp. + 7 plates; text ill. 1947.

This scholarly volume by the head of the nutrition department of the Pharmaceutical Society of Great Britain will be deemed indispensable by scientists in every country who are concerned with the standardisation of vitamins. Katherine Coward is a notable authority in the department of biochemistry which she represents. Thorough competence is reflected throughout the book.

The volume treats in Part I of: the general principles which govern the biological methods of determination of the vitamins; animals suitable for the determination of vitamins by biological methods; the determination of vitamins A, B_1, C, D, and E; the interdependence of the vitamins. Part II consists of four chapters: the standard deviation; factors influencing the accuracy of vitamin determinations; the limits of error of a determination of a vitamin; the improvement of biological assays. The appearance in 1947 of Vol. XII of Biological Symposia, *Estimation of the Vitamins*, an exhaustive discussion of this subject by specialists of high standing in America, does not render unnecessary the study of Coward's book.

E. V. McCollum

BIOPHYSICS

Elementary Medical Physics.

By Howard O. Stearns. The Macmillan Company, New York. $4.75. xiv + 354 pp.; ill. 1947.

The author has made a determined effort to point out to the student where and how the laws and theories of physics are applied in the biological sciences, and in the equipment and operation of a hospital. The topics covered are those of an introductory course in physics, viz., mechanics, heat, electricity, magnetism, x-rays, atomic phenomena, and light. The book is written in the style of an elementary textbook, with paragraph headings and many illustrations. Study questions and problems are included at the end of each chapter. The book should be very useful for pre-medical students, nurses, and physio-therapeutists, etc. A useful appendix and bibliography are included.

Titus C. Evans

X-Ray Diffraction Studies in Biology and Medicine.

By Mona Spiegel-Adolf and George C. Henny. Grune & Stratton, New York. $5.50. viii + 215 pp.; ill. 1947.

This is apparently the first comprehensive survey on x-ray diffraction for biology and medicine in the English language. X-rays are diffracted or reflected from planes of atoms and produce patterns on the recording film which are unlike those produced by light or by the electron microscope. The diffraction pattern makes it possible to calculate the spacing and arrangement of well-ordered atoms in the specimen. A diffraction pattern may show whether a material is crystalline or amorphous, whether there is distortion or strain, whether it is pure or a mixture of two or more substances, and so on. There are many possibilities for the application of the x-ray diffraction method to studies of biological materials, including fluids and blood, growing soft and bony tissues, filterable viruses, and many other substances. Other advantages, as pointed out in the introduction, are that only very small amounts of material are required, that the study does not alter the specimen for other analysis, and that x-ray diffraction studies can be carried out with colloids, deeply colored materials, and poorly soluble materials, since the method does not depend upon the use of true solutions.

The topics, which are discussed in satisfactory detail, are as follows: theory; apparatus and techniques; interpretation; x-ray diffraction studies of carbohydrates, amino acids, proteins, nucleoproteins, muscle, lipids, nerves, steroids, bones, teeth, and concretions.

Titus C. Evans

X-Rays in Practice.

By Wayne T. Sproull. McGraw-Hill Book Company, New York and London. $6.00. viii + 615 pp. 1946.

This book may be used as a textbook for students interested in x-rays and their applications. It will serve also as a reference book because of its index, bibliographical footnotes, and tables in the appendix.

The book begins with a short history of x-rays, a short chapter on x-ray tubes, and a very good discussion of the continuous x-ray spectrum or the so-called "white" radiation. These chapters are followed by one on characteristic x-rays, and by two on the interaction of x-rays and matter. A discussion of x-ray generating equipment is succeeded by a chapter on the rudiments of radioactivity. Several chapters then follow which will be of especial interest to the radiologist and radiobiologist, discussing the topics of the measurement of radiation, protection, radiography, and radiotherapy. The last half of the book deals primarily with industrial radiography and x-ray diffraction studies.

Titus C. Evans

THE BIOLOGIC FUNDAMENTALS OF RADIATION THERAPY. *By Friedrich Ellinger, with a preface by Maurice Lenz. Elsevier Publishing Company, New York.* $5.00. xvi + 360 pp.; ill. 1941.

The author has here compiled, in textbook form, some results and problems of radiation biology that are of importance in the practice of radiation therapy. The book deals with the effects of roentgen, gamma, alpha, beta, neutron, ultraviolet, and visible radiation on various tisues and organs of the human body. There are many topics, and these are treated in summary rather than in detail. The result is a very good book for introductory reading for radiologists and for biologists who are interested in the biologic effects of radiations. The original edition was in German and the literature cited is predominantly European. Together with the references given in Duggar's *Biological Effects of Radiation* (McGraw-Hill, 1936) this provides the biologist with a good list of such references up to 1936. An enormous amount of work in this field has been done since that date, but an investigator will do well to read Ellinger's book before attempting to read all of the more recent reports.

TITUS C. EVANS

LES BASES PHYSIQUES ET BIOLOGIQUES DE LA ROENTGENTHÉRAPIE. *By Paul Lamarque with the collaboration of Pierre Bétoulières, Jean Reboul, Edmond Debains, and Pierre Lorimy; preface by André Strohl. Masson et Cie., Paris.* 300 fr. (paper). xii + 530 pp.; ill. 1942.

This book by Paul Lamarque and his collaborators is a comprehensive text designed primarily for the training of radiologists, but it will also be of value to the biologist who is interested in the effects of x-rays. It begins with chapters on the nature and properties of x-rays, continues with a discussion of the physical and chemical effects of x-rays, a description of apparatus related to x-rays, and concludes with biological aspects. The biologic portion considers x-ray effects on the cell; the modification of radiosensitivity; quantitative considerations; the so-called wave-length factor; the action of x-rays on tissues, tumors, and inflammations; biologic dosimeters; techniques of radiation therapy; radiation damage and protection problems; and in the final chapter, theories of biologic effects of x-rays. The bibliography includes 651 references, some of which are as recent as 1940.

TITUS C. EVANS

AN INTRODUCTION TO COLOR *By Ralph M. Evans. John Wiley & Sons, New York; Chapman & Hall, London.* $6.00. x + 340 pp. + 15 plates; text ill. 1948.

The trouble with the study of color is that it does not fall exclusively within any of the major scientific domains. Color is a problem for the physicist, because the stimulus to color must be specified ultimately in terms of the distribution of radiant energy in it. It is also a major concern of the physiologist because the exact nature of the receptive cells, photochemical reactions, and neural connections which mediate color vision are still incompletely understood. And, finally, it falls properly within the psychologist's purview because color is a subjective experience; it depends on a conscious being and is influenced by his attitude, mood, and set. In one respect, this is an unfortunate state of affairs in that the physicist, physiologist, and psychologist very often do not understand each other, even though they may be working on closely allied problems.

Evans has filled at last a long-standing need for a unifying text on the science of color. His book starts with the nature of the physical stimulus, proceeds next to the physiology of vision and the psychophysics of color vision, and then shows how the mind influences the subjective experience of color. The book ends with some chapters on illuminants, paints and pigments, color in photography, color in art, and design and abstraction. Since Evans is a physicist, it is natural to expect that his discussion of psychological problems might perhaps be inadequate. Puristic psychologists will undoubtedly object to the way he speaks of the mind, for example, as though it were an entity. However, these lapses seem of minor importance. The author has done a masterly job of coordinating some extremely difficult material from diverse fields.

Pedagogically speaking, the book is a model. Evans begins as though the reader had never seen a graph, yet before he is through the reader has been led through some extremely difficult concepts in physics and sensory psychology—color temperature, ICI diagrams, and perceptual constancy, just to name a few. The book requires no mathematical background beyond high school algebra, and it is possible for Evans to do the job he has done only through an extensive use of clear illustrations and drawings (there are 304 in the book).

The publishers are especially to be complimented on the format of the book. The type is clear, the layout attractive, and the illustrations are reproduced beautifully. Especially noteworthy are the 15 full-page color plates, each of which illustrates a point much better than any verbal description could possibly do. All in all, this is a book which students of the science of color, whether they be experts or beginners, will enjoy reading and will want to own.

A. CHAPANIS

BIOCHEMISTRY

GENERAL CHEMISTRY. *An Introduction to Descriptive Chemistry and Modern Chemical Theory.*

By Linus Pauling; Illustrations by Roger Hayward. W. H. Freeman and Company. $4.25 (textbook ed.); $5.00 (trade ed.) viii + 595 pp.; ill. 1947.

Linus Pauling has an enviable reputation as an expositor of modern chemical theory. Now his clear and incisive style has been employed in creating an outstanding elementary textbook of general chemistry. This book is definitely not just another textbook among the multitude available. The author has been at some pains to organize his material in accordance with modern concepts and to insure a straightforward development of the subject.

The first ten chapters lead the student (assumed to have had no previous instruction in chemistry) through a clear and logical discussion of the nature and properties of matter, stoichiometry, relations between the chemical elements, valence and chemical bonding, and oxidation-reduction reactions. The first chapters of a detailed descriptive nature then appear, dealing with chromium, manganese and related metals, and with the halogens. The following 23 chapters deal with descriptive chemistry and theoretical subjects (electrolysis, reaction rates, gases, solutions, equilibrium, acids and bases, etc.) in a well-organized sequence. The chapters on theoretical subjects are presented in sufficient detail to provide a solid basis for students majoring in chemistry. It is inevitable that in a book which covers so wide a range of material many sections appear somewhat abbreviated. However, there is no portion of the book which does not serve as an admirable point of departure for the instructor planning his lectures.

The text is profusely illustrated in a most attractive manner, and many numerical examples to illustrate general principles are worked out. Beginning with Chapter Two, all chapters are accompanied by well-prepared sets of problems. The format and print are generally excellent. Some of the figures appear to have suffered in reproduction, at least in the copy examined.

There is little doubt that the general dissemination and use of this book will exert a salutary influence on instruction in beginning chemistry courses.

MARTIN D. KAMEN

LE pH ET SA MESURE. *Les Potentiels d'Oxydo-Réduction le rH. Bibliothèque Scientifique Belge; Section Biologique. Fourth Edition.*

By M. Huybrechts. Masson et Cie., Paris. 400 fr. (paper). 474 pp.; ill. 1947.

It would appear that this text is intended as a basis of instruction in the elements of the subject rather than as a guide to precise measurements, for it is deficient in useful tables, important references, and details of technique. Nor has it an index. Undoubtedly this book will serve its purpose well among those who prefer the French language, but American readers will be disappointed in the discussions of theoretical principles, several of which have not been modernized.

W. MANSFIELD CLARK

MECHANISMS OF REACTIONS AT CARBON-CARBON DOUBLE BONDS. *Lectures on Progress in Chemistry.*

By Charles C. Price. Interscience Publishers, New York. $2.50. viii + 120 pp. 1946.

It is rare to find a book such as this in which so much is contained in so little space. In 120 pages the author has managed to cover in a clear and concise manner the reactions of olefinic compounds, bringing to bear the best substantiated evidence available on the mechanisms of the reactions discussed. A well integrated treatment of vinyl polymerization reactions is a special feature.

In an overcondensed first chapter, a brief review of resonance and mesomerism introduces a discussion of the author's own contribution—an attempt to explain satisfactorily orientation in aromatic nuclei by using only electrostatic interactions based on the available data for bond angles and atomic radii. It would have aided the presentation of this material considerably, as far as clarity is concerned, if the author could have been induced to expand this section appreciably beyond the confines of a lecture. Some readers who will applaud the author's courage in expressing dissatisfaction with resonance concepts (p. 8) will balk at his rather indiscriminate lumping (p. 9) of "hyperconjugation" (essentially a concept involving molecular orbitals) with resonance (usually based on an atomic orbital approach). This is, however, a minor criticism. The author has done much to help the reader by including sample calculations of polarizing force for various substituent groups. However, it will be necessary for the reader to supplement this discussion by reading some original references. Had the latter material been included in this book, it would have aided greatly in getting the reader through some of the difficulties occasioned by the terseness of the text.

To me it seems that the approximations in the calculations have somewhat optimistically been minimized. There is also difficulty in understanding why the change in electron distribution is assumed to occur in such a way that both para and ortho positions have a high (or low) electron density relative to the meta position when an electron-repelling or electron-attracting sub-

stituent approaches the ring carbons. Despite these uncertainties it must be admitted that Price makes out a good case for his proposal. All chemists who esire to remain abreast of modern developments in organic chemistry should own this book.

MARTIN D. KAMEN

PREPARATION AND MEASUREMENT OF ISOTOPIC TRACERS. *A Symposium Prepared for The Isotope Research Group.*

By D. Wright Wilson, A. O. C. Nier, and Stanley P. Reimann. J. W. Edwards, Ann Arbor. $1.80 (paper). viii + 108 pp.; ill. 1947.

This paper-bound booklet consists of a series of eight succinct articles on various practical aspects of isotope application, written by outstanding workers in the field. Each article is accompanied by a selected bibliography. Because of its practical nature, its brevity, and its authoritative authorship, this little book has been of great value to a large number of investigators who have been using isotopes in their work. Although now two years old, it is still of great value for the above reasons. One of its features is its emphasis upon the value of stable isotopes as tools in biological research. In this connection, everyone using stable isotopes should read Rittenberg's article on mass spectrographic analysis, because of the illuminating explanations which the article gives.

Books on the use of isotopes in the biological field have appeared in numbers in the past few years. Much of their emphasis is on radioactive tracer methods. Among those which will be found helpful in amplifying the briefer treatment of radioactive tracers given in the Edwards lithoprint, and which have already been reviewed in this journal, is *Actions of Radiations on Living Cells*, by D. E. Lea (QRB 22: 330. 1947). Reviews of others will appear shortly.

FREDERICK W. BARNES

UN SYMPOSIUM SUR LES PROTÉINES. *Médicine et Biologie, Number 5.*

By A. Tiselius, D. P. Riley, E. Gorter, D. G. Dervichian, M. Joly, J. Brachet, P. Rebuffat, R. Vendrely, C. Wunderly, Y. Desreux, H. Dieu, M. Dubuisson, J. Jacob, E. J. Bigwood, M. Jutisz, E. Lederer, G. Hamoir, P. Desnuelle, M. Rovery, M. Errera; edited by Marcel Florkin. Masson & Cie., Paris; Editions Desoer, Liege. 440 fr. (paper). 285 pp.; ill. 1947.

This small volume presents the proceedings of the Seventh Congress of Biological Chemistry held at Liège early in October of 1946. It has been put out as the fifth in a series of monographs on medicine and biology under the editorship of Marcel Florkin. The meeting was organized by the Société de Chimie Biologique, and was one of the first post-war opportunities offered our European colleagues for the exchange of information and ideas in the field of biochemistry. The topic they chose to cover centered around the biological and chemical characteristics of proteins.

The book consists of the seventeen papers presented during the symposium, as well as a report of the discussions that followed each contribution. With the exception of one essay, that by Tiselius, all are in French. The topics covered are quite varied in extent. Certain of them may be selected as affording a representative picture of the scope of the conference. Tiselius opened the proceedings with a paper that discussed the methods available for the isolation and identification of protein fragments. He gave a description here of the relatively new procedures being developed in Sweden for separating amino acids and peptides by displacement analysis. This method gives promise of being extremely useful as a tool in the analysis of such problems as the components of the protein molecule. There is also an excellent summary by D. P. Riley of the use of x-rays in the determination of the structure of crystalline proteins. Many American workers will find the contributions by M. Dubuisson and J. Jacob on the proteins of muscle of great interest. These papers contain data on the characterization of what would appear to be components of muscle protein that change in composition during muscular activity. Brachet has contributed a highly stimulating paper on the synthesis of proteins and ribonucleoproteins. Other topics considered are surface chemistry and monomolecular layers, the structure of thymonucleate, the effect of x-rays on nucleoproteins, partition chromatography, and others.

In general, while this book does not contain much that will be new to the American reader of biochemical literature, it is of some value as a means of arriving at an understanding of what our European colleagues are doing and thinking about in this particular field of biochemistry.

S. SPIEGELMAN

CRYSTALLINE ENZYMES. *Number XII of the Columbia Biological Series. Second Edition, Revised and Enlarged.*

By John H. Northrop, Moses Kunitz and Roger M. Herriott. Columbia University Press, New York. $7.50. xxii + 352 pp. + 17 plates; text ill. 1948.

The first edition of *Crystalline Enzymes* marked the culmination of the second major revolution in the history of enzymology. The first had been the demonstration by Buchner that enzyme activity was a chemical phenomenon, quite separable from the living cell. The second began with Sumner's demonstration, in 1926, that an enzyme, urease, could be isolated as a pure crytalline protein. Sumner's conclusion as to the protein nature of enzymes was subjected to the most rigorous test by Northrop and his colleagues, and the first edition of *Crystalline Enzymes* summarized the methods of enzyme isolation and the data on purity of a number of enzyme proteins.

There is an obvious correlation between this advance, which made it possible to think concretely about enzymes, and the tremendous interest in enzyme reactions that is manifest in all branches of experimental biology today. Not only do we tend more and more to think of biological mechanisms in terms of enzyme reactions, but enzymes are coming into ever greater use as experimental tools. Many a cytologist and histologist will not only read the general discussions in the present work, but will also make use of the detailed "recipes" for the preparation and testing of the enzymes discussed.

In part, the present work, in which Kunitz and Herriot have collaborated with the author of the first edition, continues the plan of that edition. The preparation, behavior, estimation, and criteria of purity are given in detail for a number of enzymes. To the original chapters on pepsin, chymotrypsin, trypsin, and carboxpeptidase (and their precursors and inhibitors) are now added chapters on ribonuclease and hexokinase. There is considerable new material on the older enzymes. There are also chapters on crystalline diphtheria antitoxin and bacteriophage, whose purification was made possible by the methods developed in the preparation of crystalline enzymes. All of this material is given in sufficient detail to be useful to the average chemically-minded biologist.

The new edition also includes several chapters of more general interest. There is an enlarged discussion of the resistance of living cells to enzymes. Northrop has contributed a provocative essay on the question of protein synthesis, considered by some to be the central problem of contemporary biochemistry. In this essay he reviews the small body of existing information and speculation on this question, and advances a working hypothesis of protein synthesis based on the postulation of a "proteinogen," an autocatalytically-reproducing type-protein, from which the numerous specialized proteins of the cell differentiate. This hypothesis is applied to virus formation, antibody formation, and enzyme adaptation. While no direct experimental support of the hypothesis is available, it would seem to be a true working hypothesis, in that a search for the proteinogen should be entirely feasible. It would seem to be more feasible, however, if greater attention were paid to the structural proteins of the cell, which normally end up in the biochemists' waste crock.

While the field of enzyme chemistry is rich in general works, most of these concentrate on enzyme reactions rather than on the properties of the enzyme molecule itself. *Crystalline Enzymes*, while it does not claim to be comprehensive, is unique in giving the reader the "feel" of the subject of enzymes.

DANIEL MAZIA

ADVANCES IN ENZYMOLOGY *And Related Subjects of Biochemistry. Volume VII.*

Edited by F. F. Nord. Interscience Publishers, New York and London. $8.75. xii + 665 pp.; ill. 1947.

Volume VII of *Advances in Enzymology* deals with a wide variety of topics, extending from the biochemistry of hypertension to industrial fermentation. It is not to be expected that all of the subjects discussed can be of interest to the general biological reader. In at least a few instances, this expectation is fully realized.

The book starts out with an essay entitled Permeability and Enzyme Reactions, by S. C. Brooks. The title of this essay is unfortunately a literally accurate description of its contents. Both permeability and certain aspects of enzyme reactions are considered. They remain, however, two distinct problems. The attempt to disclose the relations between them is not overly successful. The only connection actually established by the author is that the existence of enzymatic reactions does complicate the classical diffusion approach to permeability. The time would appear to be ripe for an analysis that will at least recognize the possibility that the act of permeation by a molecule or ion may be an enzymatic one and not a mere passive transfer that must precede entrance into the enzymatic reactions of the metabolic cycle.

The second article is by W. Seifriz and is entitled: The Properties of Protoplasm with Special Reference to the Influence of Enzymatic Reactions. The properties considered consist for the most part of physical ones, as, for example: viscosity, elasticity, spirality, etc. The author warns at the outset that "each fact and each hypothesis in this review of the properties of protoplasm is considered quite independently of enzymes, but when experimental evidence indicates that catalytic action is probably involved, then this is stated." In view of the aspects of protoplasmic behavior which have been chosen for emphasis by the author, it is perhaps not surprising to discover that he finds it difficult, if not impossible, to relate his discussion to the facts and principles of modern enzymology.

P. D. Ritchie presents an admirably clear review and

discussion of the problem of asymmetric synthesis. While his viewpoint is primarily that of an organic chemist, he is well aware of the biochemical implications of the experiments he discusses. Biologists will find this article both interesting and informative.

Hevesy, one of the pioneers and founders of modern radioactive tracer methodology, contributes an interesting and scholarly review of recent applications of radioactive indicators. Recent advances in our knowledge of bacterial luminescence have been summarized by F. H. Johnson, one of the active workers in that field.

H. Theorell, an outstanding investigator of the hemoproteins, provides a comprehensive review of the present status of this biological number group. There then follows a discussion by S. Granick and H. Gilder on the related problem of the tetrapyrroles. In this article, the major purpose has been to summarize the available data and methods of attack on the mechanism of pyrrole synthesis. This whole problem has received a tremendous stimulus as a result of the recent discovery by Shemen and Rittenberg which suggests that the initial stage of porphin ring synthesis involves glycine as the nitrogenous precursor. The authors have been eminently successful in presenting a clear and readable account which effectively synthesizes the biological and chemical data on this problem.

A noteworthy article is the one by H. McIlwain, entitled: Interrelations in Micro Organisms. The author has considered here a problem to which relatively little attention has been drawn, viz.: the maintenance of adequate levels of coenzymes and other vitamin-like substances which are used in catalytic amounts with very high rates of turnover. The now classic investigation of the Lwoffs on the roles of coenzymes I and II as growth factors for *H. parainfluenzi* are summarized here, along with McIlwain's own important contributions on the microbial metabolism of pantothenic acid.

Other topics discussed include: The Oxidation of Organic Sulphur in Animals (Claude Fromageot); Antibiotics from Fungi and Green Plants (F. Kavanaugh); Kidney Enzymes and Essential Hypertension (O. Schales); and finally, Industrial Fermentation (F. M. Hildebrandt). The last article mentioned will undoubtedly be of interest to those who are interested in industrial fermentation, and will unquestionably be informative to those who are somewhat informed on this subject.

As usual in this series, Volume VII is well indexed both as to authors and subjects.

S. SPIEGELMAN

VITAMINS AND HORMONES. *Advances in Research and Applications. Volume V.* *Edited by Robert S. Harris and Kenneth V. Thimann. Academic Press, New York.* $7.50. xvi + 478 pp.; ill. 1947.

This useful set of reviews comprises six on the vitamins and five on the hormones. There is a thought-provoking contribution from the Berne laboratory, in which von Muralt deals with the work on thiamine and peripheral neurophysiology published during the war in journals still lacking in most U. S. libraries. A group of three articles illustrates the inner complexities of steroid hormone administration: Estrogens in the Male Mammal (Emmens and Parkes); Androgens in Women (Carter, Cohen, and Shorr); Testosterone in Man (Heller and Maddock). Melnick and Oser, writing on Physiological Availability of the Vitamins, draw an important distinction between a food's vitamin content and its vitamin availability, and point out that species differences exist with respect to the latter. Two useful special articles by Bird and by Morris concern the specific vitamin requirements of the chick and the mouse, respectively. Other reviews included are: Synthesis of Vitamin A (Milas); The Pteroylglutamates in Man (Darby); Growth and Adrenocorticotrophic Hormones (Li and Evans); Antithyroid Agents (Charipper and Gordon).

Enormous labor goes into the preparation of articles of this kind, which above all are informative. One query, however: Since hormones are part of the subject matter of this series, could not the reviewers more generally add to their burdensome tasks the delightful role of οἶστρος?

H. R. CATCHPOLE

BIOCHIMIE ET MÉDECINE. *Actualites Médicales. By L. Massart. Editions "Erasme" S. A., Bruxelles; Masson & Cie., Paris.* 200 fr. (paper). 72 pp. 1947.

In this little monograph an effort has been made to convey within the very restricted compass of seventy pages certain recent developments in biochemistry. Among topics considered are tracer methodology, enzymes, vitamins, hormones, intermediary metabolism, nutrition, etc. The treatment is general and elementary in character, the text apparently being intended for medical practitioners who are desirous of being brought up to date on biochemical research. Examples relating to developments in histochemistry, bacteriology and immunochemistry, chemotherapy, and pathology are given.

The writer devotes a few pages to an appeal for modernizing medical teaching in Belgium. Many of his remarks about the isolation of the medical student from anything but the most superficial contact with

physics and chemistry are applicable not only to Belgium but also to many other parts of the world.

MARTIN D. KAMEN

QUELQUES ASPECTS DE LA CHIMIE DES MÉDICAMENTS. *Médecine et Biologie, Number 7.*

By A. Lespagnol. Masson & Cie., Paris; Editions Desoer, Liège. (paper). 205 pp.; ill. [No date]. This 200-page booklet is a collection of lectures that were given before students of pharmacy at the University of Liège. In a well planned introductory chapter on Pharmacodynamic Activity and Chemical Structure, the author deals, among other points, with the effects of optical asymmetry, of isosterism, and of other structural modifications upon the nature and degree of physiological activity and the antagonistic effects produced, e.g., in vitamins, by such modifications. The following chapters are organized according to chemotherapeutic principles, but give as much chemistry, documented by clearly arranged schemes of structural formulas, as pharmacological data. The important advances made in the past decade, in the U.S. as well as abroad, in the study of Hypnotics and Analgesics, Local Anesthetics, and the Morphine group are described. Other chapters deal with such modern developments as natural and synthetic Oestrogens, Ergot Alkaloids, and Antimalarias. From the chapter on the novel Antithyroid Sulfur Derivatives, we learn that the effects of such compounds had been discovered during the war in France, independently of the work in the U.S., by a physician who studied a spontaneous outbreak of goiter in an aminothiazole factory (p. 151). In a chapter on the structure of penicillin, the author apologizes, with a grain of Gallic salt, for the fact that all his information on this subject is by word of mouth —comparing it to tom-tom communication in the African bush—because of the absence of authoritative publications three years after the cessation of hostilities.

Each chapter is followed by a few selected references to important original and review articles. We have found very few factual mistakes. While the information given by Lespagnol is, for the most part, accessible in domestic reviews and textbooks, his monograph will be useful for any pharmacological, medical, and chemical library as a source for French synonyms of chemotherapeutic agents. It will also serve well as reading material for courses in Scientific French, and is apt to dispel our frequently supercilious attitude towards modern French science.

GERTRUDE D. MAENGWYN-DAVIES

ORGANIC SYNTHESES. *An Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals. Volume 27.*

Edited by R. L. Shriner. John Wiley and Sons, New York; Chapman and Hall, London. $2.25. vi + 121 pp. 1947.

Procedures for synthesizing 36 organic chemicals. Included are β-alanine, 4-ethylpyridine, 1-methyl-1-(1-naphthyl)-2-thiourea, stearolic acid, and other substances of biologic interest. The volume also contains a cumulative index for Volumes 20 through 27 of the series.

PRACTICAL METHODS IN BIOCHEMISTRY. *Fifth Edition. By Frederick C. Koch and Martin E. Hanke. A William Wood Book, The Williams & Wilkins Company, Baltimore.* $3.00. x + 419 pp.; ill. 1948.

The latest edition of this well known manual was essentially complete at the time of the senior author's death, the galley proofs having been in his hands. As noted by the authors, the main changes made in the text have been an "expansion of the material on manometric methods, the addition of microbiological methods for vitamins and amino acids and the introduction of new or revised colorimetric and fluorometric methods." The section on microbiological methods describes, in the careful and accurate style characteristic of this book, typical examples of assays conducted with the aid of microorganisms and contains many references to the rapidly growing literature in this field. These include a description of the biochemical mutations of *Neurospora* and their application to this work.

This new edition appears to be in general as up to date as possible in such an active field as biochemistry and within the scope set by the authors, who have intended the manual to be primarily a practical companion to Mathews' *Textbook of Physiological Chemistry.* This scope is of course a broad one and enables the work to serve a variety of interests within its general field.

JOHN E. CUSHING

A LABORATORY MANUAL OF PHYSIOLOGICAL CHEMISTRY. *Sixth Edition.*

By D. Wright Wilson. The Williams & Wilkins Company, Baltimore. $2.50. 275 pp. 1947.

This book is intended to be used as a teaching manual and not as a comprehensive reference book. Experiments have been chosen to furnish knowledge and experience in biochemical techniques without requiring the extensive use of special apparatus. The manual has

been used by medical, dental, and veterinary students with success. It is clearly printed and well written. Part I deals with general subjects, such as standard acids and alkalis, electrolytic dissociation, colloids, alcohols, carbohydrates, etc. Part II is entitled Body Tissues and Fluids, but deals with muscle, bone, the cell nucleus, metabolism, etc., as well. The manual is recommended to those who do not have special aims and requirements that render the book unsuitable. A reviewer cannot say more than that the course for which this book was prepared appears to be an adequate one.

CHANDLER MCC. BROOKS

TECHNIQUES DE LABORATOIRE. *Chimie Physique, Chimie Biologique, Chimie Clinique.*

By M. Abribat, D. Bertrand, C. Carpeni, J. Delsal, P. Desnuelle, D. Dervichian, A. Dobry, A. Dognon, M. Faure, Cl. Fromageot, M. Gaultier, J. Grégoire, P. Grabar, N. B. Halpern, F. Lachampt, Fr. Lachiver, R. Latarjet, J. Leloup, J. Loiseleur, M. Macheboeuf, P. Meunier, J.-J. Pérez, Y. Raoul, J. Roche, A. Rousselot, G. Sandor, A.-M. Staub, N. Thoai, A. Vinet, and G. Wolfromm; with a preface by M. J. Trefouel. Masson et Cie., Paris. 1600 fr. (paper). vi + 907 pp.; ill. 1947.

Prepared by a large group of French scientists, this book is a compendium of techniques employed in physical, biological, and clinical chemistry. The volume opens with a section entitled Généralités, which deals with such varied topics as the calibration of glassware, the preparation of standard solutions and buffers, dialysis, and the calculation of errors. This is followed by a section on physico-chemical techniques of importance to biology: the measurement of pH, viscosity, surface tension, osmotic pressure, redox potential, etc. The third section is devoted to biological chemistry, and includes chapters on the microchemical analysis of the more important elements, methods for the isolation and study of proteins, fats, and carbohydrates, and certain immunological techniques. The book concludes with an account of clinical chemical procedures.

Like all such cooperative enterprises, this volume suffers from unevenness. Some subjects are covered in great detail, some rather cursorily, some not at all, and in addition there are inevitable variations in quality. Perhaps the main defect of the work is its over-ambitiousness. An attempt has been made to cover too vast a field in the space available. Consequently, while the book has the general character of a work of reference, a scientist who wants really thorough information on a specific analytical problem may well be disappointed if he searches for it here. As an example, one may cite the chapter on the determination of amino acids. This chapter contains detailed descriptions of colorimetric methods for determining fifteen individual amino acids, but it fails to give either methods of separation or alternative methods of determination (e.g., microbial bioassay). The book really falls between two stools—it is too extensive to serve as a laboratory manual, and at the same time it is insufficiently comprehensive to be a really useful work of reference. Despite this drawback, it contains detailed information on many chemical techniques of interest to the biologist.

R. Y. STANIER

LABORATORY INSTRUCTIONS IN BIOCHEMISTRY. *Second Edition.*

By Israel S. Kleiner and Louis B. Dotti. The C. V. Mosby Company, St. Louis. $2.75 (paper). 245 pp.; ill. 1946.

This is the second edition of a manual originally published in 1940. The text has been altered somewhat by the inclusion of some new procedures, the expansion of sections on calculation, and the deletion of a chapter on food analysis. The material presented is based on courses given by the authors at New York Medical College and is written mainly with the needs of medical students in mind. It does not appear that this manual departs in any significant way from conventional presentations. The print is rather faint, but probably adequate for its assumed life of one year. Large blank sheets are available for student notes. The manual sports a plastic loose-leaf binding.

MARTIN D. KAMEN

A BIOCHEMICAL HYPOTHESIS OF THE GENESIS OF CANCER. *Annals of the New York Academy of Sciences, Volume 50, Article 1.*

By Louis A. Pinck. The New York Academy of Sciences, New York. 50 cents (paper). Pp. 1–18. 1948.

This 17-page pamphlet presents an interesting hypothesis concerning the chemistry of carcinogenic compounds. It is an extension and modification of Fieser's speculations concerning the possible correlation between chemical reactivity and carcinogenicity. Numerous examples of the actual reactivity of cancer-producing chemicals have been given. In other instances the possible reactivity of hypothetical metabolites of carcinogens were discussed. On the basis of these considerations, an attempt has been made to predict that some hitherto unprepared compounds would be found

to be carcinogenic. It is somewhat unfortunate that it has not been possible to include any data on the testing of these hypothetical carcinogens. If and when such data appear, it must be remembered that approximately one out of four compounds tested so far have be found to be carcinogenic.

Most of the common carcinogens have been mentioned and discussed by the author, but it would be interesting to learn how the author would fit such compounds as carbon tetrachloride into his scheme. Then, too, carcinogenic physical agents, such as gamma and roentgen radiation and ultraviolet light, have been omitted from consideration. If Pinck's hypothesis becomes useful in predicting and discovering new carcinogens, these will have to be added to an already crowded list. Finally, if it does become possible to correlate the action of every carcinogenic chemical agent with a specific reactive group such as that postulated here, there will still remain the basic and mysterious problem of how the reactions of these compounds bring about the transformation of a normal to a malignant cell.

FRANK H. J. FIGGE

MICROBIOLOGY

ANNUAL REVIEW OF MICROBIOLOGY. *Volume I. Edited by Charles E. Clifton, Sidney Raffel, and H. Albert Barker. Annual Reviews, Stanford, California.* $6.00. viii + 404 pp.; ill. 1947.

This volume is the first of a new series which should be a very valuable companion to the *Annual Review of Biochemistry* and the *Annual Review of Physiology.*

Reviews included are: Morphology and cytology of protozoa (D. H. Wenrich); Antigenic variation in protozoa (J. A. Harrison); Life cycle of malarial parasites (C. G. Huff); Variation in phytopathogenic fungi (C. M. Christensen, E. C. Stakman, and J. J. Christensen); Variation in phytopathogenic viruses (L. O. Kunkel); Some aspects of the problem of growth factors for protozoa (A. Lwoff); Bacterial metabolism (D. D. Woods); Nitrogen metabolism (E. F. Gale); Industrial fermentations (M. J. Johnson); Quaternary ammonium compounds (O. Rahn and W. P. Van Eseltine); Antibiotics (R. G. Benedict and A. F. Langlykke); Chemotherapeutic agents (E. M. Lourie); Immunochemistry (H. P. Treffers); Some aspects of immunization (J. Freund); Medical and epidemiological aspects of enteric infection (A. J. Weil); The rickettsiae (N. H. Topping and C. C. Shepard); and Respiratory viruses (T. Francis, Jr.).

The author index is complete and good. Only one error was noticed in it. The subject index appears to be somewhat inadequate for a work that contains such a wealth of condensed information. For example, *Mycobacterium tuberculosis* is mentioned under bacterial metabolism (p. 125), under quaternary ammonium compounds (p. 180), and under antibiotics (p. 195), but is not listed in the index. It is true that a detailed subject index would take a considerable amount of space. Nevertheless, the question may be raised whether there should not be a very complete subject index or else none at all. It must be admitted that the indexing of chemical substances is much more complete than the indexing of microorganisms.

Since much of the material is so new, portions of the text approach "mere compilations of the literature" rather than the "critical appraisals" claimed in the preface. This is not the fault of the reviewers. It is due to the fact that the literature contains all sorts of unconfirmed reports, which are seldom if ever refuted because relatively few workers bother to write papers giving primarily negative results, and even fewer editors of journals care to print such refutations. Thus a considerable body of false knowledge is built up (especially in the field of antibiotics) to annoy future students and searchers of the literature.

WALTER C. TOBIE

BIOLOGY OF PATHOGENIC FUNGI. *Annales Cryptogamici et Phytopathologici. Volume VI. Edited by Walter J. Nickerson: Foreword by J. G. Hopkins; in cooperation with R. W. Benham, A. L. Carrión, R. Ciferri, C. W. Emmons, J. Lodder, D. S. Martin, A. de Minjer, R. L. Peck, P. Redaelli, M. Silva, J. W. Williams and F. T. Wolf. Chronica Botanica Company, Waltham, Massachusetts.* $5.00. xx + 236 pp. + 9 plates; text ill. 1947.

It should be said at the outset that the present volume is not, as its title implies, an account of the biology of pathogenic fungi, but is, rather, an account of the biology of certain fungi parasitic on man. The book is of special interest, therefore, to medical mycologists, dermatologists, and general medical practitioners.

As stated by the distinguished dermatologist, J. G. Hopkins, in his foreword, in this important volume Nickerson has "... collected summaries by pioneers in different phases of the subject. It records what has been accomplished and indicates more emphatically how much needs to be done ..." There appear as authors of the various sections of the volume a galaxy of internationally known medical mycologists and investigators. Nickerson has himself not only written an important introductory chapter to furnish a back-

ground for the more specialized sections, but he has also, either alone or with able collaborators, contributed material on the nutrition and metabolism, metabolic products, and respiration and fermentation of human pathogens.

After the foreword and introduction, there follows a chapter by the Dutch investigators, Lodder and de Nimjer, on the biology of the pathogenic Torulopsidoideae. Here, after a historical survey of our knowledge of *Torulopsis neoformans*, virulent parasite of the central nervous system, are considered such topics as the symptomatology and pathology of torulosis, its epidemiology, and its pathogenesis. Material follows on the morphology, and cultural, physiological, and taxonomic aspects of the species. As for all succeeding chapters, a comprehensive bibliography is appended.

Chapter 3, by A. L. Carrión and Margarita Silva, deals with chromoblastomycosis and its etiologic fungi. In the forty pages accorded this topic (the most extensive treatment in the volume) both clinical and mycological aspects of the disease are considered. Under the latter category, morphological and physiological data on the various dermatiaceous fungi commonly considered to cause the disease are included. Briefer accounts of the biology of *Pityrosporum ovale*, the yeast-like organism associated with dandruff scales, and of *Coccidioides immitis*, the cause of "Valley fever," are contributed by R. W. Benham and C. W. Emmons, respectively. There follows a chapter by Ciferri and Redaelli of Pavia on recent advances made by the Italian school of mycopathology from 1941–1945. This discussion covers only taxonomic work, clinical cases being omitted. An important feature of this chapter is a bibliography of 25 titles of Italian papers published during the war years.

F. T. Wolf has contributed a chapter of 23 pages on the action of sulfonamides and antibiotic agents on human pathogens. This is followed by a discussion of the geographic distribution of systemic fungus diseases, by D. S. Martin.

The four remaining chapters deal with the physiological aspects of certain pathogens. Here are included accounts by Nickerson and Williams on nutrition and metabolism, two by Nickerson alone on metabolic products, and on respiration and fermentation, and one by Peck on the lipids of fungi. The volume closes with author and subject indexes.

In assembling "review papers" by authorities in the various fields of the study of human fungus pathogens, Nickerson has done good service both to mycology and to medicine. Although the reader may be at first a bit confused by the variety of subject matter and by the different styles of writing of the thirteen contributors, he will be left with the very definite feeling that there is essential unity in the volume and that this unity arises from the fact that "... the group of fungi to which these pages are devoted possess in common the ability to parasitize man ..."

F. K. SPARROW

MYCOPATHOLOGIA. *Volume IV, Number 1, 1947. Edited by R. Ciferri and P. Redaelli. Dr. W. Junk, Amsterdam.* Fl. 36.— per volume of 4 parts.

This journal devoted to mycopathology has resumed publication with Volume IV, Number 1, following a wartime lapse of nearly four years. The five articles in the present issue are all by Italian workers. (One of these contributions, Die Systematik der Actinomycetin, by E. Baldacci, is also obtainable from the publisher as a separate, at a price of f. 2.50). The international character of the journal will no doubt reappear in the next issues.

GENERAL BACTERIOLOGY. *Second Edition. By D. B. Swingle; revised by W. G. Walter. D. Van Nostrand Company, New York, Toronto, and London.* $3.50. xiv + 319 pp.; ill. 1947.

Like the first edition of this introduction to bacteriology, the revision, carried out by W. G. Walter, stresses the general biological relationships of the bacteria, molds, yeasts, viruses, rickettsias, and the pleuropneumonia group rather than the great mass of detail found in so many textbooks of bacteriology. In some instances the treatment is almost too sketchy, particularly in the chapter on the history of bacteriology. Relatively little space is devoted to medical aspects of the field, which so often dominate introductory textbooks, but the material has been selected to bring out the fundamental principles of immunity and disease.

Review questions at the end of each chapter deal with the immediately preceding material, are very specific, and in general do not oblige the student to go beyond the book for answers. This means that the questions are not so thought-provoking as they might be.

The book is fairly up to date, an exception being the treatment of the bacterial nucleus and of mutation. The classification used conforms to the 6th edition of Bergey's *Manual of Determinative Bacteriology*. The electron microscope is given its full due, and there is an appreciation of the significance of bacteriophage.

The format is pleasing, with well spaced print and a good quality of paper. The illustrations, many of them

photographs, are clear and interesting. The book is shorter and smaller than comparable textbooks.

SUZANNE GLASS

LABORATORY MANUAL FOR GENERAL BACTERIOLOGY. *Third Edition.*

Compiled by George L. Peltier, Carl E. Georgi, and Lawrence F. Lindgren. John Wiley & Sons, New York; Chapman & Hall, London. $2.50 (paper). viii + 295 pp.; ill. 1946.

This is a loose-leaf, commendably clear laboratory manual that emphasizes general principles and the structure and behavior of groups of microorganisms, rather than the special characteristics of individual species. Thus there is a section on the morphological and chemical nature of bacteria, the species being chosen to illustrate the chief structural and chemical variations as brought out by different stains. There is a section on metabolism and the products of microbial growth, the species used illustrating different kinds of action on carbohydrates, nitrogenous compounds, and lipids, different relationships to oxygen, etc.; and a section on factors that influence the growth of microorganisms, a section of experiments in which various physical and chemical agents are applied to a number of species that differ in the degree to which their growth is affected by such agents. There are also exercises on applied phases of microbiology, including dairy, sanitary, food, soil, and medical bacteriology, and one exercise on the determination of unknown species. Preliminary exercises on the microscope, and on pure culture technique, are given, as well as an introductory survey of microorganisms, including yeasts and molds.

One of the most valuable features of the manual is the list of thought-provoking questions at the end of each exercise. A list of textbooks is provided for reference in answering these questions, but the page numbers given may prove misleading as editions change. A pleasing feature of the format is the provision of adequate space for students' notes.

SUZANNE GLASS

MICROBIOLOGIE GÉNÉRALE ET TECHNIQUE MICROBIOLOGIQUE.

By Paul Hauduroy. Masson & Cie., Paris: F. Roth & Cie., Lausanne. 1250 fr. (paper). 624 pp. 1947.

Despite its title, this book is in no sense a treatise on general microbiology, as that term is currently understood. Although the author has attempted to broaden the scope of his undertaking by the inclusion of brief sections on the history of bacteriology and the biology of microorganisms, his main purpose has clearly been to give a practical account of the principal bacterial agents of human infectious disease, and of the techniques involved in their isolation and study. This volume is essentially a handbook for the laboratory technician.

Following a brief historical introduction (of which more will be said below), a section of fifty pages is devoted to the general biology of microorganisms, the nature of infection and immunity, and the classification of bacteria. At best, fifty pages would allow only a cursory and superficial survey of these important subjects; the treatment here adopted is, however, incorrect and misleading as well as superficial. For example, the author makes no distinction between spirilla and spirochaetes, both groups being dismissed with the astonishing statement: "les spirilles ne rentrent pas à proprement parler dans le monde des microbes tel qu'on l'entend habituellement." The biochemical activities of microorganisms are covered in a single page of trivialities. One cannot help feeling that the author would have been wiser to omit all discussion of these and similar topics.

The third section of the book deals in considerable detail with technical methods for the study of pathogenic bacteria. This is followed by an extended account of the principal bacteria pathogenic for man, with much emphasis on diagnostic procedures. The fifth section describes various special techniques of interest to the medical bacteriologist—water and milk analysis, the determination of germicidal power, penicillin assay—with four pages on mycological technique thrown in for good measure. The book concludes with a hundred pages of formulae and definitions. Much of the information in this section (e.g., the properties of common chemicals, conversion tables, preparation of decinormal solutions) can be found in any chemical handbook and is hence superfluous.

Here one might end, but for—yes, something really must be said about that historical introduction. Like most historical accounts by medical bacteriologists, it ignores the contributions of such masters as de Bary, E. C. Hansen, Winogradsky, and Beijerinck, but in addition it has a much graver defect—a strong aroma of chauvinism. The section opens innocently enough with a chronological tabulation of important discoveries, and this is followed by brief biographies of various bacteriologists. It is not easy to display one's prejudices in tabular form, and the author's attitude only becomes clearly evident in the subsequent biographies. German bacteriologists are coldly dismissed in a few lines, while their French counterparts receive half a page or more of eulogy. One gathers that the French-

men, in addition to being Glories of France, had most of the moral virtues that we associate with the ideal boy scout. Unfortunately for Gallic pride, there is one German who simply cannot be passed off in five lines —Robert Koch. In consequence, Hauduroy devotes over two pages to the assassination of Koch's character, full attention being given to his conflicts with Pasteur and to the fiasco over the announced cure for tuberculosis.

The uninstructed student who may read this alleged "history" would undoubtedly conclude that medical bacteriology had been established by the heroic exploits of a little band of Frenchmen, headed by the almost superhuman figure of Pasteur. A few trivial points were established on the other side of the Rhine, but the German bacteriologists were mostly nasty people, so they don't deserve much scientific credit (vide Koch). Perhaps this is dealing at unnecessary length with a matter better left in silence, but such vulgar distortions of historical fact should not be allowed to appear unchallenged.

R. Y. STANIER

PROPOSED BACTERIOLOGICAL CODE OF NOMENCLATURE *Developed from Proposals Approved by the International Committee on Bacteriological Nomenclature at the Meeting of the Third International Congress for Microbiology. Publication authorized in Plenary Session.*

Edited by R. E. Buchanan and Ralph St. John-Brooks. The Iowa State College Press, Ames. $1.00 (paper). 61 pp. 1947.

PARASITOLOGY

LABORATORY DIAGNOSIS OF PROTOZOAN DISEASES. *Second Edition.*

By Charles Franklin Craig. Lea & Febiger, Philadelphia. $6.50. 384 pp. + 7 plates; text ill. 1948.

In 1942 Colonel Craig published a book that was welcomed by all persons attempting to diagnose the protozoan diseases of man. It presented detailed descriptions of a wide variety of laboratory diagnostic techniques, with evaluations by the author. That exceedingly practical and valuable book has now been brought up to date by a second edition.

Due to the impetus of World War II, a great deal of work was done on perfecting parasitological procedures. The author has selected from the newer work those developments that he feels to be most significant. Only a few of the new additions can be cited here. Several new staining methods for intestinal protozoa have been added. Hakansson's aqueous smears for the diagnosis of *Dientamoeba fragilis* and the destruction of *Blastocystis hominis* has been recommended. Among other cultivation methods, Nelson's alcohol extract medium for *Endamoeba histolytica* and Lourie's, Senekjie's, and Weinman's media for the hemoflagellates are included. The recent work on the successful cultivation of malarial parasites by Ball and his co-workers is discussed but not presented in detail, since the method is not a practical diagnostic procedure. The J.S.B. method of staining malarial parasites in thin and thick blood films is given.

Not only has the book been improved by the addition of recent developments but also by the inclusion of valuable earlier work that did not appear in the first edition. For example, Quensel's method of staining amoebic trophozoites in temporary mounts is now described and recommended.

With the exception of the addition of new techniques, the second edition is very similar to the first. A few additional illustrations have been added, while those reprinted from Aimee Wilcox's manual greatly improve the chapter on the diagnosis of malarial parasites in thick blood films. The list of references has been increased by nearly one hundred articles, although it should still not be considered as complete.

M. M. BROOKE

MANUAL OF MEDICAL PARASITOLOGY: *With Techniques for Laboratory Diagnosis and Notes on Related Animal Parasites.*

By C. Courson Zeliff. State College, Pennsylvania. $3.75 (paper). xiv + 159 pp. + 1 plate; text ill. 1947.

Despite its faults, which on the whole are minor, this manual should prove to be exceedingly useful in college and university courses devoted to medical parasitology. It is primarily a laboratory guide, presenting the morphological details of the organisms and the various diagnostic techniques.

The characteristics of the parasites are presented in keys, tables, charts, and illustrations reprinted from other textbooks. Unfortunately some of the illustrations have lost considerable clarity, as a result of being considerably reduced in size. A colored plate reprinted from the manual by Huff, 1944—by typographical error acknowledged to "Hoff"—adds materially to the attractiveness of the manual.

The author is to be commended on familiarizing the student with some of the recent parasitological litera-

ture. References to original articles are cited in the text and in footnotes along with some of the conclusions of the authors. At the end of the manual there is a list of the major textbooks, manuals, and journals devoted to parasitology. A number of features in the manual should greatly assist the student. There are sections devoted to medical terms, to basic parasitological definitions, and to terminology. The etymology of the generic and species names of the important parasites is given, in order to help to explain some of the complicated names that have been given to the human parasites. A detailed index and table of contents will assist the student to locate desired information.

Unfortunately there are a number of typographical errors. Heidenhain is misspelt "Haidenhain", Chagas' disease becomes "Chaga's". The lack of a comma between "Sen Gupta" and "Napier" might lead the student to interpret these as the name of a single investigator. In describing the cysts of *Endamoeba histolytica*, the word stain is used in the place of strain in the following sentence: "Cysts are about 5 to 20 μ in diameter according to the stain."

About one-third of the manual is devoted to laboratory diagnosis and laboratory technique. A wide variety of procedures is presented in considerable detail. At the end of this section directions are given for the preparation of solutions, stains, and reagents.

M. M. BROOKE

VETERINARY PROTOZOOLOGY.

By Banner Bill Morgan and Philip A. Hawkins. Burgess Publishing Company, Minneapolis. $4.00. x + 195 pp. + 1 plate; text ill. 1948.

Veterinary protozoology has become increasingly important during the past few decades, and it is timely for a textbook dealing exclusively with the protozoan diseases of veterinary importance in North America to be published. The present book has grown out of the teaching materials that the authors have used in courses on the subject at the University of Wisconsin and at Michigan State College.

After an introductory chapter devoted to general aspects of protozoology, separate chapters consider the protozoa of horses, cattle, sheep and goats, swine, dogs and cats, poultry, and furbearers. The clear, concise presentation of the morphology, life histories, pathology, diagnosis, treatment, and control of the parasitic protozoa will be appreciated by both practising veterinarians and others who are concerned with this field parasitology. All four classes of the Protozoa have parasitic representatives to be found in most of the domesticated animals discussed. The flagellates and sporozoans are the ones most frequently incriminated as the cause of disease. The amoebae are relatively unimportant, and although ciliates are in great abundance in some hosts, they are apparently harmless. Poultry seem to have the greatest opportunity of being adversely affected by protozoans, and species of the Coccidia are probably the greatest offenders.

The book contains 24 excellent plates with large illustrations of the various protozoa discussed. A number of the figures have been redrawn from other authors, but many are new. Unfortunately, there are no references to the figures in the text, which may be a handicap for some. Three maps present the distribution of dourine anaplasmosis and *Boophilus annulatus* in the United States.

There is a brief chapter on the diagnosis of the protozoan diseases that presents many of the standard parasitological techniques. The appendix includes a parasite-host list, treatment schedules for the most common protozoan diseases, a list of important books and journals, and a bibliography of 309 articles of interest to veterinary protozoologists.

M. M. BROOKE

HEALTH AND DISEASE

PHYSICAL FITNESS, APPRAISAL AND GUIDANCE.

By Thomas Kirk Cureton; assisted by Frederick W. Kasch, John Brown, and W. G. Moss. The C. V. Mosby Company, St. Louis. $6.00. 566 pp. + 1 chart; text ill. 1947.

The problem of differentiating between health or normality, on the one hand, and poor health in the absence of disease, on the other, frequently presents a formidable problem. Where there is disease, the accepted procedures of diagnosis are usually of value. The relation of "health levels" to productivity, social adjustment, and the happiness of individuals is no less important, however, and despite much work it is, as this book silently attests, an elusive thing.

The authors are under no illusions about the evaluation of health levels and physical fitness. Their first chapter deals with the central question: What is physical fitness? This is easily answered for the authors, by a complicated chart of concentric rings in which organic condition is at the center, surrounded successively by physique, motor fitness, sensory fitness, and skills. The ideal is, apparently, to score well in each of these areas. Given a normally functioning body, the individual, in order to be ideally physically fit, must enjoy gymnastics, aquatics, skiing, skating, ball games, racquet games, sailing, camping, etc., etc. Fitness in these activities naturally depends upon the other more central features of fitness noted above. Physical education, therefore, is related to physical fitness in so far as it develops habits, understanding, and skills about one's self with respect to physical fitness and sports. This all makes good sense, so far as it goes. It leads the

authors next to consider the best tests for physical fitness. There follow thirteen chapters, in five sections, dealing with: Physique; Cardiovascular Condition; Respiratory Fitness, Motor Fitness; and Guidance.

The chapters that make up the bulk of this textbook are full of facts, methods of measurement, methods of tabulating data and for scoring fitness. These will be of utmost value to those who are concerned with physical education. The book ought to be of equal value to physiologists, psychologists, and sociologists, however, and should stimulate them to inquire: Are mere physical endurance, stamina, and motor skill necessary conditions for a productive, happy, and socially well adjusted life?

The physiologist will look at many of these tests with a critical eye. There is no doubt that they measure something, but what is it? Are they tests of tests? The discussion of somatotypes, for example, is complete and will satisfy those who must measure somatotypes. Yet there is no doubt that many of the conclusions reached in this discussion are empirical and lack a scientific basis of fact. The discussion of the Cureton technic for measuring body fat shows it to be empirical, too. Data are obtained by it and described in detail. Now no one will deny that extremes of fat and thinness are undesirable, but what constitutes a *significant* increment of fat? In this test, numerical scores are obtained and letter grades are assigned for fat in cheek, abdomen, hip, gluteal region, and rear and front thigh. A critical reader will want to know how a score of D is any more indicative of poor "physical fitness" than one of C. Nowhere in the discussion of the relation of weight to physical fitness is there any mention or evaluation of the specific gravity test developed by Keyes. Is it useful or not? In a book on the appraisal of physical fitness, the student wants full discussion and evaluation by the experts.

The section on tests for cardiovascular fitness are most complete, and all who need to apply them will find here a useful compendium. He will also find a fair account of their physiological basis. There is again lacking, however, a critical evaluation of how the results of these tests are actually related to physical fitness in a fundamental sense. The pulse-scoring tests, for example, are among the most favored tests for evaluating physical fitness; yet it is known that frequently older individuals may obtain high scores, or that individuals without much endurance (e.g., those with rheumatic or other types of heart disease) may score high. This is not so much a criticism of the book under review as it is a plea for less emphasis generally on numerical scores as a means of judging fitness. The use of the heartometer provides a case in point. An excellent description of the use of this instrument for analyzing pulse waves is given, and many tests with it are cited. Numerical data concerning the characteristics of pulse waves are quoted in extenso, with standard scores for excellent, very good, good, average, fair, poor, and very poor. The percentile distribution of these is given. If, then, we speak of the frequency of a score, that is one thing, but if one goes on to state what is a "good" and what is a "poor" score, he transgresses, it would seem, the limits of scientific objectivity. Other criticisms are equally apt. One might question the use made by the authors of the "angle of obliquity" in the systolic peaks of the heartogram pulse wave, since it is constructed arbitrarily with one *straight* side although the writing arm inscribes a radius of *curvature*.

One might go on to question the s gnificance of one or another aspect of these tests used to measure fitness. To do so, however, would detract unnecessarily from the value of a large job which has been done clearly and well. If a deficiency exists, it resides basically in the failure of physiologists to define clearly what fitness and fatigue actually are. The psychological aspects of motivation are of utmost importance, yet they do not, to judge from this volume, enter into ordinary procedures for evaluating fitness.

S. R. M. REYNOLDS

PHYSICAL FITNESS WORKBOOK. *A Manual of Conditioning Exercises and Standards, Tests and Rating Scales for Evaluating Physical Fitness.*

By Thomas Kirk Cureton. The C. V. Mosby Company, St. Louis. $2.50 (paper). xii + 150 pp.; ill. 1947.

The subtitle to this publication tells in essence what the book is. It is designed as a personal record book for all undergraduates who participate in the Physical Fitness Program at the University of Illinois. The manual is rich in test procedures and scoring methods. It has sections on Measuring Individual and Group Performance and Improvement in Physical Fitness; Use of the Work Book; Illinois Motor Fitness Screen Test; Motor Efficiency Classification; An Inventory of Motor Fitness; Commands, Formations and Lesson Plans; Introductory Flexibility Tests; Tumbling Stunts and Grass Drills for Conditioning, Balance, Flexibility and Agility; Agility Conditioning Field Exercises; Posture and Physical Development Exercises; Weight Lifting and Strength Exercises; Medicine Ball Exercises; Competitive Games and Contests; Stamina Building Routines; Somatotype Rating and Overall Evaluation of Physique; Respiratory Tests of Organic Efficiency; The Schneider Test of Cardiovascular Efficiency; the Pulse Ratio and Step Tests of Cardiovascular Deficiency. A long appendix contains rating scales and tables for the physical fitness tests and measurements.

Except at the University of Illinois, where this manual is integrated with a large program, this publication will be of most use to teachers of physical edu-

cation. It should also serve as a stimulus to physiologists to determine in what way and to just what extent many of these tests do bear a relation to physical fitness. Their relation to age, previous personal history, and occupation might also be evaluated with interest and profit.

S. R. M. REYNOLDS

SCOLIOSIS: *The Practical Approach to Treatment.* *By Beatrice Woodcock. Stanford University Press, Stanford University, California; Geoffrey Cumberlege, Oxford University Press, London.* $2.00. xiv + 111 pp.; ill. 1946.

In this book the author presents her views on the types of exercises which she considers to be indicated for cases of lateral curvature of the spine. The first part of the book is intended to lay the ground-work for a logical explanation of the "derotation" method of treatment that the author stresses. One is kept in suspense about what this "derotation" is until a third of the way through the book.

With Part II, the attempt at a scientific and logical explanation is dropped, and one reads that "by consensus of expert opinion we know in which direction to rotate the rotating vertebrae"—a statement which is given as proof that the procedure is logical. The authorities named are indeed to be considered, but others have been known to disagree with their views.

In an uncompensated curvature there is justification for a procedure which attempts to make an "S" curve out of a "C" curve, and to this end the type of exercises outlined by Beatrice Woodcock will find a usefulness. In functional "C" curves, or beginning compensatory curves in which treatment may properly be directed toward a correction of the defect in the direction of normal alignment, the type of exercises outlined in this book are definitely contra-indicated.

The references to muscle weakness as found in typical scoliosis cases are vague in some instances, and definitely incorrect in other instances. There is no clear-cut picture which indicates that the author understands the muscle imbalances as they occur in scoliosis. Exercises to stretch certain muscle groups are described as essential to reestablish normal flexibility. Exercises which lay stress on strengthening these same muscle groups are elsewhere in the book claimed to be of therapeutic value.

From a technical standpoint, a number of misleading statements are scattered throughout the book. For example, the right-angle relationship of the trunk to the legs in the sitting position with legs extended forward is considered a correct sitting position by the author in describing free movement. This position is definitely an abnormal posture for the average, normal individual.

There is a very definite need for a book on conservative exercise therapy in scoliosis, but this book does not answer that need. The routine presented should be applied only to those cases in which compensation is the treatment of choice.

HENRY O. KENDALL

HISTOPATHOLOGIC TECHNIC. *By R. D. Lillie. The Blakiston Company, Philadelphia and Toronto.* $4.75. xii + 300 pp. 1948.

The author is a well known pathologist who for many years has been interested in the principles underlying the staining of tissues as well as the improvements that can be achieved in the various uses of stains. He has contributed fruitfully to this field in the past, and the present volume reflects his interest and wide experience. Designed primarily for the use of clinical and anatomical pathologists, the book ought to serve as a handy reference and guide. The subject matter is handled in an orderly sequence starting with microscopy, equipment, fixation, etc., and including chapters on nuclear stains, cytoplasmic granules, enzymes, endogenous and exogenous pigments, various cell products, fats and lipoids, and connective and nervous tissue respectively. There is also a chapter on special procedures, such as corrosion technics, autoradiography of radioactive elements, and microincineration.

Not intended to be of encyclopedic scope, the volume contains procedures and innovations which the author for the most part has tried and found to be satisfactory. In that sense it presents some of the more recent advances in this field.

C. A. KRAKOWER

PATHOLOGICAL HISTOLOGY. *Third Edition.* *By Robertson F. Ogilvie, with a foreword by A. Murray Drennan. The Williams & Wilkins Company, Baltimore.* $10.00. xii + 459 pp. + 143 plates. 1947.

The appearance of the third edition of this volume, first published in 1940, is an index of its popularity and usefulness. Within its 447 pages of text it packs an enormous amount of information, covering the gross and microscopic features of pathological lesions in their whole pathogenetic range. The unique feature of this volume, however, is that there are 258 colored photomicrographs which are faithful reproductions of stained preparations and illustrate the lesions described in the text. These reproductions, in fact, almost constitute a good class set of slides in pathology. Armed with such a class set and this volume, the student and postgraduate should make fast headway in learning or refreshing his memory of an important field in medicine.

C. A. KRAKOWER

RECENT ADVANCES IN PATHOLOGY. *Fifth Edition*
By Geoffrey Hadfield and Lawrence P. Garrod. The Blakiston Company, Philadelphia and Toronto. $6.00. viii + 363 pp. + 31 plates; text ill. 1947.

This volume will be of interest to the graduate pathologist, medical practitioner, and anyone who desires a refresher course in pathology or a summary of recent advances in scientific information in the fields of anatomical, physiological, and experimental pathology. Certain omissions detract from the value of the new edition. The repetition of numerous chapters, unrevised, from the fourth edition prevents the information in many fields from being up to date. The consideration of rheumatic fever suffers in the latter respect; and experimental work that has clarified the pathogenesis of lupus erythematosis disseminata and periarteritis nodosa and other so-called "collagen" diseases has been completely omitted. Chapters repeated without revision are those devoted to hypersensitive states, the reticulo-endothelial system, hypertension, the ductless glands, and the digestive tract. Little has been added to discussions of diseases of the respiratory system, except for a study of silicosis, in spite of the fact that a great deal of knowledge on "atypical" and virus pneumonias has occurred in the past few years. Vitamin diseases, though summarized in the fourth edition, are not included in this volume; and the only information in the field of hematology, as before, is upon the relation of gastric and intestinal function to anemia.

The most complete and up-to-the-minute revision is on liver disease. Here there is an excellent summary of epidemic hepatitis and the relation of dietary deficiencies to hepatic disease. The chapter on nephritis has also been rewritten and simplified, unfortunately before the recent work of Trueta and his co-workers became available. Recent work on experimental cancer research forms an interesting chapter. Information as to the site of antibody formation has been added to this edition; and Menkin's work on inflammation is carefully reviewed, along with the objections to it raised by other investigators. There is also an interesting summary on the nature and effect of the "spreading factor" in inflammation. The illustrations, although not numerous, are well chosen. The bibliography is complete to the point reviewed for each subject.

ELLA H. OPPENHEIMER

A TEXTBOOK OF CLINICAL PATHOLOGY. *Third Edition. Edited by Francis P. Parker. The Williams & Wilkins Company, Baltimore.* $9.00. xx + 1023 pp.; ill. 1948.

This is the third edition of the excellent textbook of clinical pathology formerly edited by Kraske in collaboration with Parker. In this edition Parker has contributed chapters on blood chemistry, renal and hepatic function, the examination of urine and seminal fluid, and the examination of gastric contents. Kraske has contributed a chapter on the disorders of the leucocytes; and six other contributors, all experts in their fields, have written the material devoted to hematology, including methods of examining blood and bone marrow; blood grouping, including the laws of inheritance of blood groups; diagnosis of blood parasites; the assay of vitamins and hormones; the examination of sputum, including the detection of fungi and bacteria; the examination of feces, cerebrospinal fluid, exudates, and transudates; the examination of the skin and mucus membranes; immunologic tests; the diagnosis of venereal diseases and the serologic tests for syphilis.

The third edition has been completely rewritten, the material from past editions has been modernized, and the new procedures developed in the past six years have been added. For instance, in the chapter devoted to blood grouping, recent knowledge of the Rh and Hr factors has been summarized, as well as the interrelation of the subgroups of groups A and AB. In the section upon hemorrhagic and thrombo-embolic disease, dicumoral and heparin therapies are discussed; and the section on blood chemistry now includes the most recent methods of analysis.

The clinical procedures for the collection of material to be examined are described in detail, and many illustrations demonstrating techniques give additional aid to the novice. The normal standards are fully summarized for every study, and the pathology and pathogenesis of abnormal findings are amply described. Throughout the book, emphasis is placed upon the interpretation of clinical findings, and this makes the work a valuable reference book. In addition, it is an excellent general textbook of clinical laboratory procedures for the medical student and should be kept in every clinical laboratory.

ELLA H. OPPENHEIMER

THE PATHOLOGY OF TRAUMATIC INJURY. *A General Review.*
By James V. Wilson, foreword by Philip H. Mitchiner. A William Wood Book, The Williams & Wilkins Company, Baltimore. $6.00. xii + 192 pp.; ill. 1946.

This monograph on the pathology of trauma is a concise summary of scientific data compiled from recent wartime and experimental studies. It includes a comprehensive clinical survey of each subject, thereby making this work of special value to the physician or surgeon in the treatment of accident cases. It should also serve as a valuable adjunct in the accident wards of hospitals; and the teacher and student of pathology and clinical medicine will also find it of interest.

All subjects based on trauma are included in this volume—shock, burns, fat embolism, blast injury, wounds, and injuries to specific tissues. In the discussion of shock, functional pathology is stressed, and the principles of the treatment of shock, advocated by the author, are based on its pathogenesis. The chapter on burns includes pathological and experimental studies as well as a discussion of possible complications and methods of treatment. There is an excellent account of the pathogenesis of the crush syndrome and of blast injuries. Modern knowledge pertaining to the causes and pathogenesis of fat embolism are summarized. The chapter on wound pathology is excellent and devotes considerable space to complicating infections, including tetanus and gas gangrene. The factors which influence healing are discussed as a basis for treatment. There are chapters on the pathology and sequelae of closed, penetrating, and open wounds of the chest, abdomen, and pelvis and their viscera; vascular injuries and their complications, injuries to the head and central nervous system; and the pathology and healing of fractures and joint injuries. The illustrations are well chosen and there is a comprehensive bibliography on each subject, so that this work gives a complete survey of the specific subjects related to trauma.

ELLA H. OPPENHEIMER

CARE OF THE BREAST.

By Else K. La Roe. Froben Press, New York. $3.75. xvi + 246 pp.; ill. 1947.

This is a compilation of accredited facts mixed with fanciful hypotheses of historical, anatomical, physiological, pathological, clinical, and therapeutic data on the subject of the mammary glands. The material is presented in slip-shod and repetitious fashion, with a bias that is amazingly naive. For the author devotes the greater part of the volume to her personal theories and classifications, including her theory of the origin of cancer, her methods of breast examination, her brassiere developed on "Langer skin tension lines"; and her "slanting" technic and "tunnel graft" methods of plastic breast surgery, used by her for aesthetic purposes as well as for medical necessity.

The usefulness of this volume appears to be limited. The surgeon will need a more comprehensive survey of the literature and would find this quite superficial; the medical practitioner, however, might find the survey of sites of origin of specific tumors and their relation to age groups of practical value and interest. The pathologist must shudder at the unscientific classifications and the complete lack of use of histology in the differentiation of disease. Many of the illustrations should interest a medical historian. Undoubtedly the layman—or rather the laywoman—is the person who will be most interested in this book; and its scientific terms are amply defined for her in the glossary. The author's intention is to make women "breast conscious" and "aware that a competent doctor should be consulted at the first sign of any change or peculiarity" in the breasts, so as to facilitate an early diagnosis of cancer and thereby to reduce its dangers.

ELLA H. OPPENHEIMER

TUBERCULOSIS. *A Discussion of Phthisiogenesis, Immunology, Pathologic Physiology, Diagnosis, and Treatment.*

By Francis Marion Pottenger. The C. V. Mosby Company, St. Louis. $12.00. 597 pp.; ill. 1948.

Every chapter of this clearly organized and richly illustrated handbook on tuberculosis is an authoritative document of the broad-minded scholarship of an experienced clinician, one who may well be proud of "the more than 50 years spent in the practice of medicine." His approach to the clinical and etiologic aspects of the disease is largely immunologic and always remains free of unwarranted or dogmatic assertion. The presentation is concise, reasonably optimistic, and in excellent style, and there is little doubt in the reviewer's mind that the new book ranks with the best written on the subject.

Of particular interest to genetically oriented readers will be the author's confession to having "very little phthisiophobia," as well as his emphasis on the part played by inherited tissue qualities in "protecting one person and making another vulnerable." Tuberculosis he looks upon as a mildly infectious and potentially curable disease, which in this country has passed from the epidemic to the endemic stage and therefore affords great opportunities for preventive measures through an increased amount of attention to the most susceptible persons. Primary infection is regarded as "a vaccination," and the decline in the incidence of the disease Pottenger ascribes mainly to the steady elimination of the most susceptible.

FRANZ J. KALLMANN

LE GRANULO-DIAGNOSTIC DE LA TUBERCULOSE.

By R. Benda. G. Doin & Cie., Paris. 115 fr. (paper). 96 pp. + 2 charts; text ill. 1945.

The hematologic data presented in this small but well-documented monograph were obtained with May-Gruenwald-Giemsa stain in a fairly large series of infected patients, as well as in guinea pigs inoculated with human blood serum or tuberculous sputum. In accordance with the observations of Matis (1928), Lambin (1929) and Sandels (1938), the presence of many gross, irregular granulations in the cytoplasm of neutrophile polymorphonuclear leucocytes was found to

be a typical feature of acute cases of tuberculosis, as distinguished from such infections as pneumonia, rheumatic fever, leprosy, and subacute bacterial endocarditis. This finding was used for the development of a scheme of "granulograms" classified as normal, intermediate (±), medium (+), or extreme (++), according to the size, shape, and density of the granulations observed. Extreme granulograms were seen only in clinical tuberculosis, while the medium type occurred during the first week of typhoid fever, and the intermediate type in some cases of Boeck's sarcoid.

The author appears sufficiently optimistic about the practical applications of this cytological method to recommend its routine use in the management of tuberculosis for both diagnostic and therapeutic purposes. If confirmed as to reliability, the method may prove to be of considerable clinical value, since it is described as being economical and technically simple.

FRANZ J. KALLMANN

OCCUPATIONAL DISEASES OF THE SKIN. *Second Edition.*

By Louis Schwartz, Louis Tulipan, and Samuel M. Peck. Lea & Febiger, Philadelphia. $12.50. 964 pp. + 1 plate; text ill. 1947.

No book in the English language presents so complete and authoritative a discussion of this subject as this one. It is large, comprising 964 pages, and represents almost a lifetime of painstaking work. Dermatologists, industrial physicians, and medico-legal experts refer to it constantly. With all respect to the auth[illegible], however, one may still say that it is not comprehen[illegible] enough. The hazards of one hundred and four[illegible] occupations are discussed. Should there be a subsequent edition, the authors might lengthen the list and broaden the discussions of the hazards, for some have not been mentioned in this work.

A considerable portion of the book is taken up with discussions of diseases which are only indirectly occupational in certain instances, such as parasitic infections, bacterial infections, fungus infections, and venereal diseases. Another portion is devoted to the medico-legal aspects of occupational dermatoses.

The index is too short and is highly technical. It is often difficult for the reader, who may lack detailed technical knowledge of the manufacturing processes and chemicals used, to find what he wants to know in the book.

H. HANFORD HOPKINS

BEAUTY PLUS—*The Key to Beauty, Health, and Charm. Revised Edition.*

By Mary MacFadyen; illustrated by Frank H. Netter. Emerson Books, New York. $2.49. 272 pp. 1946.

This is a small book, but it contains 272 pages and 36 chapters. It has been written by a woman physician for women in general. A lot of territory is covered. A woman can use it as a reference book on cosmetology, posture, exercise, eating habits, drinking, smoking (including "hang-overs"), minor ailments, or her sex life from infancy to after menopause. The subject matter is presented clearly, concisely and simply. The reader should, however, not take everything said as the last word on the many subjects covered, and should avoid the dangers of too much self-treatment, which might be stimulated by too close an adherence to the advice offered in the text.

H. HANFORD HOPKINS

INTERNATIONAL DRUG CONTROL. *A Study of International Administration By and Through the League of Nations.*

By Bertil A. Renborg. Carnegie Endowment for International Peace, Washington, D. C. $2.50. xii + 276 pp. 1947.

This study of the narcotic drug problem has been written by the former Chief of the Section of the Drug Control Service of the Secretariat of the League of Nations, B. A. Renborg. He describes the supervision and control of narcotic drugs at the domestic and international level. The purpose of the volume, says the author, is to demonstrate what it is possible to achieve by international cooperation in a campaign against a common enemy of mankind. The results obtained by international cooperation in the narcotic drug field are outstanding. Narcotic drugs are indispensable to medical practice but they constitute a grave public danger when abused. The nations of the world have recognized this problem and by common agreement have placed themselves under supervision by international bodies. The results have been successful beyond the fondest hopes of the early planners. Today the spirit of international cooperation engendered in narcotic drug control is pointed to as a model of what may be accomplished by supervision and regulation of problems at the international level. The hopeful suggestion is made by Renborg that arms, munitions, and instruments of war present a danger to humanity analogous to the danger from narcotic drugs. Unless controlled by responsible authorities, weapons, like narcotics, present a danger to the individual, to the nation, and to mankind as a whole. The common danger inherent in narcotic drugs and implements of war always depends upon voluntary acts of individuals or organizations. This characteristic separates such dangers from others of international scope, as, for instance, epidemic diseases; for the latter may spread from one country to another independently of the deliberate acts of man.

In 1920 the members of the League of Nations agreed under the Covenant to entrust the League with general supervision over the execution of agreements with regard to the traffic in opium and other dangerous drugs. There then began a new phase of international cooperation in the campaign against the abuse of narcotics. The League created an administration which functioned, by common agreement among the states, on the basis of international conventions through which governments undertook obligations to submit the manufacture of and trade in narcotic drugs to stringent measures of national and international supervision and control.

The author gives an account of these activities of the League and of the system developed for international control. The record has factual value and demonstrates the success achieved for more than twenty years in world cooperation. With the dissolution of the League of Nations, its functions in this field were transferred to the United Nations. The work is now continued by the Commission on Narcotic Drugs of the Economic and Social Council of the United Nations.

There does not exist today an internationally recognized definition of the term "narcotic drug." Experts in this field have been unable to propose a definition that might be recognized internationally. The difficulty was "partly one of language, since several terms would be required to indicate with scientific precision the different kinds of drugs covered by the Convention, some of which are narcotic and habit-forming, some narcotic but not habit-forming, and some neither narcotic nor habit-forming but convertible into habit-forming narcotic drugs." Modern pharmacology should provide a terminology that would bridge this serious handicap. New synthetic narcotic substances that have recently been discovered, e.g., Demerol, will add to the difficulty of selecting a generic term suitable for the purpose of international control.

To those who have been interested in the narcotic drug problem this book will provide factual data for classroom and lecture presentation. To students of the larger problem of international relations, the record of experience provided by narcotic drug control will furnish an outstanding example of the necessary coordination in control between international authorities that must be achieved to solve problems which extend across boundaries and affect the interests of individuals and nations.

C. JELLEFF CARR

MIRACLE DRUG. *The Inner History of Penicillin.*

By David Masters. Eyre & Spottiswoode, London. 10s. 6d. 191 pp. + 17 plates. 1946.

This is a very concise and chronologic story of the interesting development of penicillin. The author gives a vivid account of the work from the original observation made by Fleming to the time when mass production of penicillin on a commercial scale was accomplished in England. It is cleverly written. It contains many interesting side lights on the struggles and devotion of the scientists in London and Oxford to their work, which will ever live as a monument to their unselfish service to medical science. The author has a tendency, however, to overwork his thesis slightly in what appears to be an attempt to establish the fact that the development of penicillin was a British accomplishment. Among scientists, this has always been recognized.

The story is very readable and has much human interest. From the point of view of a scientist, however, it contains little that is not well known to students of microbiology who have followed the development of penicillin.

W. E. HERRELL

DISEASES OF THE NERVOUS SYSTEM. *Described for Practitioners and Students. Fifth Edition.*

By F. M. R. Walshe. The Williams & Wilkins Company, Baltimore. $4.50. xvi + 351 pp. + 22 plates; text ill. 1947.

The fact that it has become necessary to reprint this book eight months after the issue of its fifth edition is a sufficient indication of its value. It is unfortunate that the author has tried to deal with the subject of the psychoneuroses. The chapter on that subject does not reflect a modern viewpoint and has had to be so cursory as to be almost valueless.

The book is intended for the use of students and practitioners and is not only sufficiently comprehensive to satisfy all their needs, but it is excellently indexed and can therefore serve as a useful reference book.

The principles of neurological examination and diagnosis are clearly and logically presented, and the whole field is comprehensively and concisely covered.

DAVID ROSS

MEDICINE IN THE POSTWAR WORLD. *The March of Medicine, 1947. Number XII of The New York Academy of Medicine Lectures to the Laity.*

By The New York Academy of Medicine. Columbia University Press, New York; Geoffrey Cumberlege, Oxford University Press, London and Bombay. $2.00. xiv + 109 pp. 1948.

This little book comprises six lectures that relate particularly to the effect of wartime experiences on medicine itself. Possibly the most significant thing about it is that, of the six lectures, three are devoted directly to psychiatric problems, and that most of the others have a bearing on social medicine. Nothing in the book will

be found new or startling to the medical reader, but there is a great deal which can be read with profit by medical men and biologists, even though couched in language readily understandable to "the man in the street." The lecturers are men of authority in their own spheres, and their approaches to their several subjects are stimulating.

DAVID ROSS

PSYCHOLOGY AND ANIMAL BEHAVIOR

PSYCHOLOGY FOR LIVING.

By Herbert Sorenson and Marguerite Malm. McGraw-Hill Book Company, New York, Toronto, and London. $3.00. x + 637 pp.; ill. 1948.

This is a textbook of general psychology for high school students. For this reason, the material covered is not quite the same as one usually finds in introductory college textbooks. There is considerable emphasis, for example, on the personal problems of high school students—how to study, worries, dating, marriage, and choosing an occupation—while such academic topics as sensation, perception, attention, and maze learning are either ignored or mentioned only briefly. This does not mean that the book is unbalanced. The contents appear to be well adapted to the interests and needs of high school students. As a matter of fact, it is rather surprising to find how many fairly advanced ideas, derived from studies of the emotions, learning, intelligence, individual differences, and the like, the authors have been able to present in a way that should make them seem real and important to the student.

In other respects, too, this book seems particularly well suited to its intended audience. The authors' style of writing is smooth and simple without being juvenile or offensive. The book is liberally sprinkled with clear, interesting illustrations. In the appendix there are (1) a list of books on vocations, (2) a glossary of technical terms, (3) a list of books on psychology and related problems for students who are interested in further readings, (4) a list of books to assist the teacher in locating material for lectures, and (5) a source list of visual aids.

This is, it seems, the kind of book every high school student should read. It is well-written, interesting, and, unlike so many popularized books on psychology, crammed full of sound, authoritative psychological information.

A. CHAPANIS

GESTALT PSYCHOLOGY. *An Introduction to New Concepts in Modern Psychology.*

By Wolfgang Köhler. Liveright Publishing Corporation, New York. $2.49. viii + 369 pp. 1947.

No extended review is required of what is a mere reissue of an 18-year-old book published under the same title in 1929 by the same publisher. Prospective readers will want to know only whether there is anything new in it, especially in view of the publisher's blurb, which says "... completely rewritten and radically revised...." The answer is, No. Except for a few footnotes, an occasional re-wording of a sentence, and a new title for an old chapter, nothing is new. Nevertheless, this remains a worthwhile book, being a capable and readable essay on the basic tenets of Gestalt psychology by its foremost exponent.

STANLEY B. WILLIAMS

SEX HABITS OF AMERICAN MEN. *A Symposium on the Kinsey Report.*

Edited by Albert Deutsch. Prentice-Hall, New York. $3.00. xii + 244 pp. 1948.

Of the plethora of symposia on the Kinsey Report, this was earliest and clearly among the best. The editor with great skill assembled a varied and authoritative group of scientists and social thinkers to present their views. The poll reveals: Yea's, 9; Nay's, 0; Qualified votes, leaning to the favorable side, 4.

The affirmative opinions come from the editor Albert Deutsch (psychiatrist and writer); Robt. J. Havighurst (professor of education); J. K. Folsom (sociologist); Clyde Kluckhohn (anthropologist); Leo Crespi (psychologist); Morris Ploscowe (magistrate); Alice W. Field (probation officer); Abraham Stone (marriage counselor); L. I. Newman (Jewish rabbi); and Sidonie M. Gruenberg (Director, Child Study Association). The sketch by Deutsch of Kinsey's personal characteristics and his methods is very interesting. As to real critiques of the Report, Crespi has provided a penetrating analysis of the statistical methods employed by the Kinsey group, pointing out the unfairness of many of the charges made by critics who have failed to note, in the first place, that this is a progress report, and, even more significantly, have failed to distinguish between a *representative*, or random, sample, and an *experimental* sample that includes a statistically adequate sample of each distinct group in the population. The latter can readily be converted into the former by appropriate weighting of the values for each group; but the former can in no way be made to yield the latter. This, of course, explains why Kinsey selected the experimental sample. Crespi, in short, endorses the methodology of the Kinsey group wholeheartedly.

It is equally interesting, perhaps, to inspect the cases of qualified approval. These stem from R. P. Knight (psychiatrist), Seward Hiltner (Protestant minister), C. G. Wilber (Roman Catholic biologist), and Robert Lindner (clinical psychologist). Knight deplores the emphasis on means rather than medians or modes, and especially the use of accumulative incidences, which

magnify the importance of occasional practices rather than customary or habitual ones. He also dislikes the insistence on sexual outlet at the expense of emotional and other mental aspects of sex (but he fails to show how these can be measured, which is the crux of the matter); and he deplores the tendency to equate high frequency and normality. These have all been frequent criticisms of the Kinsey Report by others.

The Protestant and Roman Catholic both seem to accept what they like in the Report, and demur at what they don't like. Both are concerned that what *is* may be taken for what *ought to be*. The Roman Catholic questions the validity of the conclusions of the Kinsey Report for men of that faith, because of the small size of the sample. It is small, of course, and unquestionably Kinsey will try to enlarge it. But the real question is whether it is adequate, Kinsey having shown that the statistics of a sample of a particular group, uniform as to age, educational level, religion, etc., change little after the sample has reached a total of 300–400, except for the total range.

Lindner is critical mainly of the generalizations of the Kinsey Report about the sex-life of men in penal institutions. His opinion is that the special psychological atmosphere of a prison places "sex behavior beyond the range of the statistically predictable." In particular, phantasy is rife in such an atmosphere and is hardly distinguishable by Kinsey's methods from reality. This criticism seems more justified than most.

Most notable is the scope afforded by the Kinsey Report to these friends and critics to launch forth into a fresh consideration of their own fields of investigation or social activity. The crowning achievement of Kinsey's work is perhaps just this—that it has caused every person concerned with problems of sex behavior to take stock, and then to attack with renewed vigor and deeper understanding those problems before them.

BENTLEY GLASS

TELEPATHY AND MEDICAL PSYCHOLOGY.

By Jan Ehrenwald, with a foreword by Gardner Murphy. W. W. Norton and Company, New York. $3.00. ii + 212 pp. 1948.

The subjects of telepathy and psychoanalysis are viewed by many experimental students of behavior with decided reservations, if not downright suspicion or derision. One anticipates with almost morbid relish the reaction that may be produced by the thorough admixture by Ehrenwald of these two highly controversial elements. Will these inflammable ingredients combine in an intellectual explosion, or will they compound an inert vapor that will be dissipated by the searchlight of objective scrutiny?

If the reader is willing for the sake of adventure (or on the basis of prior conviction) to accept Ehrenwald's major premises, first, that telepathy is an established fact, and second, that the Freudian conception of personality dynamics is essentially valid, he may be rewarded by an intriguing set of postulates and deductions. Certain aspects of dreams, the nature and content of psychoanalytic procedure, the meaning of mediumistic phenomena, and the underlying mechanisms of paranoia and schizophrenia are ingeniously interpreted in terms of extra-sensory thought transference. At the same time, by turning the insights of psychoanalysis to the problems of telepathy, an important source of evidence bearing on the latter acquires significance.

The unpredictable and capricious operation of the telepathic process, acting with little regard for time and space, and typically under minimal voluntary control, suggests that it is an evolutionary residue, for the most part supplanted by the more sharply discriminative, and thus biologically economical, sensory and cognitive processes. Its vivid demonstration in the dream state, under conditions of psychoanalytic rapport, in certain deficient children, in some emotional or neurotic states, and in more deviant pathological disorders, leads to the abstraction of three basic principles related to its occurrence. First, the successful agent or "sender" is characterized by partial or total repression, or by a pronounced emotional stress of certain thoughts, ideas, or complexes. Then, in the percipient there is some "minus-function" or deficit in the physiological or psychological sphere. Finally, there is a tendency to overcompensate for the deficiency by paranormal sensitivity to material from other minds. Sleep induces a transitory minus-function, and so at this time material is free to enter the dreamer's mind from the conscious, the pre-conscious, or the unconscious level of another person's mind. This material can be distorted by symbolization, condensation, and secondary elaboration by both agent and percipient, and is interwoven with items from the dreamer's own psyche and with reverberations of sensory stimulation. During receptive psychoanalytic sessions a more significant thought transference can take place, so that the analyst's interpretations often become the property of the analysand without vocal instruction, perhaps accounting for the alleged universality of a vocabulary of symbols. Similarly, the medium reveals presumably private information in the trance by telepathically tapping the sitter's conscious or unconscious. In some individuals the relevant minus-function is an intrinsic lack of rapport in inter-personal situations. At first this is compensated for by an oversensitivity to the unconscious or by repressed sadistic-aggressive tendencies to other persons; thus the paranoiac is not projecting his feelings to others, but is instead more acutely aware than his physician of the actual state of affairs in his social world! This condition may progressively deteriorate, so that the schizophrenic becomes sensitive, i

addition, to material from the preconscious minds of his fellows. His withdrawal from social contact is an attempted defence against these uncanny and threatening experiences. How the process can be neutralized or reversed by therapy is not yet clear.

Ehrenwald's manner while developing his hypothesis of heteropsychic influence has little of the combative dogmatism frequently displayed by advocates of psychoanalysis and extra-sensory research (or by their antagonists). Perhaps his casual modesty in describing an admittedly tentative system will forestall the resistance of rationalistic Freudians, of statistically inclined or spiritualistic mind readers, of skeptical traditionalists. Whether this theoretical framework represents more than a refreshing exercise in logic, the reader will have to decide for himself—if he can insulate himself against the telepathic polemics of the embattled protagonists.

FRANK W. FINGER

FUNDAMENTALS OF PSYCHIATRY. *Fourth Edition.* *By Edward A. Strecker. J. B. Lippincott Company, Philadelphia, London, and Montreal.* $4.00. xvi + 325 pp.; ill. 1947.

This is the fourth edition of a textbook designed for the use of medical students and practitioners. As with all of Strecker's books, it gives us a very clear presentation of psychiatry, its history, its usefulness in a general medical situation, and a clear description of the principal psychiatric syndromes, together with suggestions for treatment. The book is concise, it has an excellent glossary of terms, and may be recommended for the general medical group of biologists.

WENDELL MUNCIE

TWENTIETH CENTURY PSYCHIATRY. *Its Contribution to Man's Knowledge of Himself.* *By William A. White. W. W. Norton & Company, New York.* $2.50. 159 pp. 1947.

This is a reprint, under the same title, of the book which first appeared in 1936, based on White's Salmon Lectures. An introduction is followed by chapters on psychiatry as a medical specialty, or the social significance of psychiatry, and on the general implications of psychiatric thought. White's breadth of view and his early real ability to present psychiatry in an attractive form are amply in evidence in this book. At one point in his chapter on general implications, he takes a severe look at "common sense as a method of procedure" and assumes that common sense is on the way out as a scientific method. This touches on the point of view which is dear to the teaching of Adolf Meyer, and as a pupil of the latter, I can only say that it seems to me that White and Meyer are really using the same term to talk about different things or different aspects of the same thing. White talks as if common sense, that is to say, a consensus of opinion, must give way to research. Meyer never disputed this. He felt, however, that the results of research must always be finally measured along the present consensus, with the certain consequence that the exuberant claims of research would certainly be considerably toned down in the process. Meyer saw the products of research as something which must be integrated into the current common sense; and I think Meyer was right. We can see this process taking place in psychoanalysis; we see it also taking place in the physical sciences. Perhaps this is a minor item, but it serves to underscore the fundamental difference between White's and Meyer's approaches to psychiatric problems. White, as we know, was a devotee of the unusual, whereas Meyer was just as devoted to trying to increase the body of generally accepted fact. There would seem to be a place in all scientific thinking and practice for both points of view.

WENDELL MUNCIE

PSYCHIATRY FOR THE PEDIATRICIAN. *By Hale F. Shirley. The Commonwealth Fund, New York; Geoffrey Cumberlege, Oxford University Press, London.* $4.50. xii + 442 pp. 1948.

Here is a chatty volume for "the medical student and for the pediatrician and general practitioner who lack basic training in child psychiatry." By sticking wholeheartedly to his plan to make this a primer, uncomplicated by references to theories or controversies in the field, the author achieves a general effect of blandness. By inference it would seem as if various childhood problems have been thoroughly solved rather than being, as is actually true, in a constant state of flux as the psychodynamics of child development are increasingly understood.

In what is no doubt an effort to meet the average medical mind halfway, Shirley has indeed played down the more dynamic concepts of emotional development in favor of the out-dated psychobiological school of Meyer. He also refers frequently to Leo Kanner's views expressed some 10 years ago, when Kanner's book, now under extensive revision, was the classic text for child psychiatrists. It is my belief that even non-psychiatrically oriented doctors can be given really modern concepts of child psychiatry to challenge their thinking. If they have enough interest to pick up a volume with such a title as this, they deserve more real stimulation than Shirley has felt it wise to offer.

Still, this book is an attempt to fill a real gap in the training of pediatricians. Shirley covers a wide variety of topics, from the eating habits of children to the way to take an adequate social history of a patient—via such familiar landmarks as enuresis, sex, and sibling rivalry,

to name but a few. His style is discursive and occasionally painfully arch. However, he does survey the field with solid common sense and, until a more venturesome author tackles the problem, Shirley's book will be the best we have.

HELEN ARTHUR

PSYCHOTHERAPY IN CHILD GUIDANCE.

By Gordon Hamilton. Columbia University Press, New York. $4.00. xxii + 340 pp. 1947.

Miss Hamilton has written a long and sometimes cumbersome defense of the social service worker as a child guidance therapist. She uses as her chief ammunition the success of the Jewish Board of Guardians of New York in allowing social workers, under trained psychotherapists, to take on disturbed children for treatment. In view of the impressive need for child guidance workers, it would be folly for even a purist to insist that social workers have a place solely in their own discipline and need not intrude into the psychiatrists' field. The author militantly denies that mere expediency should, however, influence one to accept her position. Social work, she thinks, should embrace all aspects of dealing with a disturbed child; and when specific treatment is indicated, the social worker can do it. Excellent case histories are given of children observed under therapy being conducted by social workers at the Jewish Board of Guardians' clinic. These case histories are the most interesting and persuasive part of the book and do much to win the admiration of a skeptical reader.

It is hard to know for whom this book is really intended. Without doubt different philosophies of social work will bandy it about, although the considerations presented are hardly new to them. However, to hand this book over to "teachers, clinical psychologists, and others," as the dust jacket suggests, seems a dangerous policy. These related workers may feel that if social workers can "cure" behavior problems, they can undertake such work, too. The Jewish Board of Guardians is unique in the careful psychiatric supervision of its social service child guidance staff. Less intelligently organized groups or individuals working on their own might make a considerable muddle if they attempted such a thing.

HELEN ARTHUR

BRIEF PSYCHOTHERAPY. *A Handbook for Physicians on the Clinical Aspects of Neuroses.*

By Bertrand S. Frohman, with the collaboration of Evelyn P. Frohman; Foreword by Walter C. Alvarez. Lea & Febiger, Philadelphia. $4.00. 265 pp. 1948.

This book represents another attempt to present to the general medical public a brief and understandable description of the treatment of psychiatric illness. It is possibly over-simplified, but a good general basic conception of the dynamics and treatment of neuroses can be obtained. An early section of the book is historical and explains simply the origins of the different schools which arose from the differences between Freud and his early followers. The main part of the book is devoted to the presentation of a brief method or "active analytic method" of therapy, and refers to such other kinds of treatment as electroconvulsive therapy, narcosynthesis, active psychotherapy, hypnotherapy, and various adjuvants of psychotherapy, advocating a combination of, or alternation between, these different methods of treatment as likely to shorten the necessary duration of a treatment. As the book appears to be written for the use of people who are unlikely to give such treatments, all this hardly seems necessary. The book is simply and clearly written, and includes a considerable glossary, as an appendix tactfully entitled "glossary for patients." The index is well prepared and likely to be of use.

DAVID ROSS

PSYCHIATRY IN NURSING.

By Raymond Headlee and Bonnie Wells Corey. Rinehart & Company, New York. $3.50. xii + 308 pp. 1948.

This handbook of nursing raises the question of the primary objective of such a book. It seems to attempt to combine a textbook of psychiatry for nurses with a section (Part III), on Psychiatric Nursing. In this the authors appear to fall between two stools. The latter subject is not covered extensively or thoroughly enough, although it gives many valuable suggestions regarding to the nurses' understanding of and approach to mental illness. There is also some quite valuable psychiatric material bearing on the nurse's own psychological state.

A chapter on Study Hints, Appendix A, probably quite a new feature in such a book, is of itself an admirable attempt; but to be adequate it would have to be almost a small handbook in itself—condensation has made it rather indigestible for one who is not already familiar with the concepts listed. The chapters on Sleep, Pain, and Sexual Adjustment are also quite new. They are logically and reasonably treated. In general, the book presents a mixture of exceedingly simple and rather complex treatment of three aspects of one subject. Somehow it manages to be a useful book in the end.

DAVID ROSS

THE PSYCHIATRIC STUDY OF JESUS. *Exposition and Criticism.*

By Albert Schweitzer; Translated and With an Introduction by Charles R. Joy; Foreword by Winifred Overholser. The Beacon Press, Boston. $2.00. 81 pp. 1948.

The Psychiatric Study of Jesus was written in 1913. Albert Schweitzer was then already a doctor of philosophy, a doctor of divinity, and a renowned organist, a famed interpreter of the music of Bach. He had, furthermore, finished his medical studies. This book was his thesis for the degree of doctor of medicine.

Four writers, German, French, American, and Danish, respectively, had won considerable notoriety at the time by writing books in which they advanced the theory that Jesus of Nazareth was a psychopathic type—more specifically, a sufferer from paranoia. Schweitzer's thesis is a refutation of such views, in the light of the best medical knowledge of his time. His arguments are very powerful and illuminating.

He insists, in the first place, that anyone who makes such claims must base them on the facts of the case history. Apart from the unreliability of historical facts in general, this means that in analysing the mental state of Jesus, we must limit ourselves to those parts of the gospels accepted by scholarship as historical. This clearly rules out the gospel of John, from which most of the supposed evidence of paranoia had been cited. Secondly, Schweitzer points out that no man lives in a vacuum. The common beliefs of the people of Jesus' generation, race, and religion—in particular, beliefs in the imminent advent of the Messiah, the coming of the Kingdom on earth, and the angels—can in no way be regarded as symptoms of mental aberration in him. Again, the occurrence of hallucinations is not confined to the mentally ill. Jesus' failure to develop a persecution complex and his complete change of view as to his own mission—from that of the earthly Messiah to the One who had to die for his followers—these are also held to be incompatible with paranoia. As to the two last points, modern medical opinion may differ with Schweitzer, but the other reasons are as cogent as ever. Schweitzer completely and finally demolished the theory of a paranoid Jesus.

This is a medical thesis, as we have said, but it is a medical book such as only a man who was also both trained historian and devout theologian could have completed. It is a monument to the many-sided genius of one of the truly great men of this century. English-speaking people throughout the world will be grateful for this translation.

BENTLEY GLASS

THE YEARBOOK OF PSYCHOANALYSIS. *Volume 3. 1947.*

Edited by Sandor Lorand. International Universities Press, New York. $7.50. 309 pp. 1948.

In this third volume of the *Yearbook*, the editors have selected twenty contributions, by almost as many authors, to represent the high marks of the psychoanalytic literature of the year. It is not possible to give an evaluation of all these articles here. They cover a wide range of subjects from the history of psychoanalysis and research problems, if by the latter we may include speculative interpretations, to treatment procedures and that favorite of psychoanalytic literature, the mythology and folk lore of peoples.

Of the several contributions the following may be singled out for special mention: An Unknown Autobiographical Fragment by Freud (Siegfried Bernfeld); A Valedictory Address (Ernest Jones); Notes on Development in the Theory and Practice of Psychoanalytical Technique (Payne); The Anti-Semitic Personality (Brunswik and Sanford); and Constant Elements in Psychotherapy (Oberndorf). This last-named contribution I believe will rank with Kraepelin's *Manifestations in Insanity* (1921) as a mile stone in psychiatry for its willingness to abandon a parochial viewpoint. For a reasoned and reasonable approach to treatment remarkably free of dogmatic bias, one would look in vain elsewhere in the psychoanalytic literature for anything to approach Oberndorf's statement, so far as I am aware. This kind of statement can only be made by a person of vast experience, a broad grasp of the functioning of personality as opposed to dogmatic conceptions of it, and an essential sort of honesty and humility in approaching the psychiatrist's task. In selecting these few statements for special mention, it is not implied that the other contributions suffer by comparison. The volume is remarkably stimulating and provocative.

WENDELL MUNCIE

PSYCHOANALYSIS AND THE SOCIAL SCIENCES. *An Annual; Volume 1.*

Edited by Geza Rôheim. International Universities Press, New York. $7.50. 427 pp. 1947.

According to the editor's foreword, this annual presents the psychoanalytic point of view for all subjects from anthropology to sociology. The book is accordingly subdivided into parts dealing with anthropology, mythology, religion, literature, history, and sociology. The editor stresses that while this is an exclusively psychoanalytic publication, in the strict Freudian sense, factual contributions on subjects of interest to the psychoanalyst are welcome. This first volume is therefore, it would seem, a mixture of factual material, with little direct psychoanalytic interpretation, and exclusively psychoanalytic material, in some cases with little factual background.

In a very interesting introduction entitled Psychoanalysis and Anthropology, the editor discusses the convergencies and divergencies of the two disciplines. This becomes a eulogism on *Totem and Taboo*, and

strikes the note for the more strictly psychoanalytic contributions which follow, for they too might all be lumped as reworking the primal horde theme of "Totem and Taboo."

Considering that the editor has stated that factual material of interest to psychoanalysts would be accepted, considerable cold water is thrown on his offer by the last paragraph of his introduction, in which he says: "It is true that anthropologists for the most part still use psychoanalytic terms without understanding their meaning. . . . Nobody can really understand what it is all about without having been analyzed. Few would go with me so far, yet I will go a step further. If we are really to understand psychoanalytic anthropology in the Freudian sense, it will have to be written by those who have not only been analyzed but actually practiced analysis themselves. Without this practice, nobody can acquire real skill in deep interpretation, and without constant contact with the unconscious we are likely to repress the results of our own analysis and resistance will gradually get the upper hand." As for understanding the data of folk lore or of anthropology or sociology, ". . . a complete therapeutic analysis of a primitive is by far the best. Only an analyst who lives in the country can do that. . . . The next best to this is what the field anthropologist can do if psychoanalytically trained." In a foot note, Róheim goes so far as to say: "If lay analysts are not going to be trained, psychoanalytic anthropology should be in the hands of M.D.'s who are also anthropologists." In other words, Róheim stands virtually alone as eligible to understand anthropology from the psychoanalytic standpoint.

There are contributions by Kluckhohn, Roheim, and Spitzer concerning anthropology; by Bunker on mythology; by Bunker, Feldman, Hitschmann and Lorand on religion; by Bergler and Oberndorf on literature; by Loewenstein on history; by Hartmann, Kris and Leites, and Sterba on sociology.

To the reviewer, who is not an analyst but is interested in all of these issues, these contributions seem of quite variable value. Kluckhohn's article is exceedingly factual and does not go very far afield in deriving dynamic interpretations. Bunker's two articles and Feldman's are quite interesting, particularly the last, as again offering factual matter. Oberndorf discusses Nathaniel Hawthorne and indicates that Hawthorne's insight, as expressed in his creative products, had little or no therapeutic effect on his own difficulties. Hartmann's article, On Rational and Irrational Action, appears longwinded and really offers nothing new about personality structure and functioning. Kris and Leites, writing on Trends in Twentieth Century Propaganda, are exceedingly interesting when they compare propaganda in World War II with that in World War I. Sterb's article on Some Psychological Factors in Negro Race Hatred and in Anti-Negro Riots I find most disturbing. Using as material the Detroit riot of a year or so ago, Sterba makes astonishing analogies with psychoanalytic interpretations which seem only humorous. For instance, when Negro race riots are regarded as essentially identical with fox hunting, and then the fox is identified without further ado as a penis, simply because he runs into a hole in the ground, what can one say?

The purpose of such an Annual as this would be better served, it seems, if it were under the direction of a less biased Freudian. The correlations—between the unconscious—as expressed in dream analysis, etc., and in neurosis and primitive culture must remain essentially a serious topic but scarcely one to be handled best by people who already are convinced they know the answers. A critical reader will find much of interest and value in this volume, and I for one shall continue to read it, seriously in spots, with amusement in others, being one of the great unwashed who can't possibly understand the full implications of some of the gems cast before us. Yes, such a volume is exceedingly interesting.

WENDELL MUNCIE

THE PSYCHO-ANALYTICAL APPROACH TO JUVENILE DELINQUENCY. *Theory: Case-Studies: Treatment.* *By Kate Friedlander. International Universities Press, New York.* $5.50. viii + 296 pp. 1947.

Kate Friedlander has written an excellent book on the psychodynamics of juvenile delinquency. Studying various types of delinquents from the psychoanalytic point of view, she has been able to draw conclusions not only about the reasons why individuals are delinquent but also as to how a delinquent must be treated if he is to be reclaimed by society.

Part I is devoted to a very lucid explanation of how social adaptation normally takes place during emotional development. Part II gives descriptions of what happens when social adaptation fails to take place. The antisocial character, the common offender, the neurotic delinquent, and the sex delinquent are discussed in the perspective of their emotional development. Part III deals in a realistic and forthright manner with the treatment of juvenile delinquents. This might have been a very bitter discussion, for our penal workers, judges, probation officers, and our very laws are far removed in most cases from accepting (or understanding) a truly rehabilitative approach to the individual delinquent. The author, however, points without recrimination to the route we must follow if our young offenders are to get constructive handling. She stresses the need for diagnosing each delinquent's personality and then for an intelligent use of psychotherapy or environmental readjustment. Some offenders can benefit from psychoanalysis, some can respond to special training schools, and some will be responsive to a trained parole officer or to a social service placement. It will take money to effect a change in our treatment

of the juvenile delinquent, yet no more than we now spend in the almost completely futile effort to lock every young offender up.

Every adult who works with children should read this book. The word "psychoanalysis" in the title does not indicate a theory but rather a method of investigation. Friedlander has a real talent for expressing psychodynamic material in clear, practical terms. Only by comprehending the meaning of antisocial activity in the juvenile delinquent can sincere, thoughtful men and women become more positive forces for dealing with the growing problem of young criminals.

HELEN ARTHUR

HUMAN BIOLOGY

FIJIAN VILLAGE.

By Buell Quain, With an Introduction by Ruth Benedict. The University of Chicago Press, Chicago. $5.00. xviii + 459 pp. + 24 plates + 2 maps; text ill. 1948.

In 1935–36 Buell Quain, who unfortunately died on a field trip in Brazil in 1939 at the age of 27, spent a year in an inland village, Nakoraka, on one of the Fiji islands, Vanua Levu. There he studied intensively all aspects of life (livelihood, life cycle, kinship, etc.) in this primitive village, where the existence of a nobility, based on general ancestor worship, was the most significant feature. A most interesting introductory study of Fijian history by the author reveals that many traits in this obviously old and genuinely primitive culture were imported only a hundred years ago by Tongan invaders, who had been armed by Wesleyan missionaries. Quain thus explains the inconsistencies and uncertainties in the cultural ideals and social organization of these Fijians by the relatively recent grafting of Tonga culture on an older and different Fijian culture. The author's early death is the more to be regretted because his monograph, covering a very little-known and by now probably thoroughly "acculturated" area, is such an excellent piece of work. He strikes the right balance between concrete reporting and conceptual abstractions, avoiding equally well diffuse gossip and arid generalization.

ERWIN H. ACKERKNECHT

THE COWRIE SHELL MIAO OF KWEICHOW. *Papers of the Peabody Museum of American Archaeology and Ethnology, Harvard University, Volume XXXII, Number 1. By Margaret Portia Mickey. Peabody Museum of American Archaeology and Ethnology, Harvard University, Cambridge.* $2.50 (paper). x + 83 pp. + 8 plates; text ill. 1947.

In the southern provinces of China live millions of so-called "aborigines," agriculturists who differ from the Chinese in speech and dress though in little else that is obvious. Margaret Mickey has lived in a village of one of these groups, and has recorded their simple peasant life with its agricultural and home activities, feasts, ceremonies in the event of sickness or death, etc. As almost nothing is known concerning these "aboriginal" groups, this monograph, although strictly descriptive and none too complete, is a welcome addition to ethnographic literature.

ERWIN H. ACKERKNECHT

THE WHALE HUNTERS OF TIGARA. *Anthropological Papers of The American Museum of Natural History, Volume 41: Part 2.*

By Froelich G. Rainey. The American Museum of Natural History, New York. 70 cents (paper). Pp. 227–284. 1947.

A cultural study of an Alaskan Eskimo village of whale hunters. The main sections deal with the Social Structure of Tigara Village in the Nineteenth Century, the Native Economy and the Yearly Cycle before 1900, and Native Theory i.e., tales of origin, the supernatural, and the roles of shamans.

MARÍA: THE POTTER OF SAN ILDEFONSO.

By Alice Marriott; with drawings by Margaret Lefranc. University of Oklahoma Press, Norman. $3.75. xxi + 294 pp.; ill. 1948.

Some time ago this reviewer suggested that the variations upon which natural selection acts might more likely be physiological than morphological, and that therefore evolution might occur in populations in which there was little or no morphological differentiation. The late William E. Ritter, in commenting on that theory, pointed out that since there is no difference between the hands of those Indians who weave blankets and of those who make pottery, and that since each pueblo is characterized by its own peculiar type of pottery, a situation that might reasonably be interpreted as being one of so many instances of physiological differentiation, the pueblo Indian populations might possibly afford an instance of physiological evolution in actual process. It seems appropriate therefore, that the biography of the best known potter of the pueblos should be reviewed in a periodical devoted to the biological sciences.

This work is not a complete biography, however, as the author states in her Foreword. There are many things of a religious, a political, or even of a personal nature which common courtesy requires shall not be divulged, and the experience of Indians with Caucasian honor has impressed upon them the inadvisability of

being too confidential with a paleface. So qualified, this is the narrative of life in a pueblo which, since its original independence, has been under the governments of New Spain, the Republic of Mexico, and the United States. The story covers six generations, for María, who now has grandchildren of her own, can remember her own great-grandmother. Indeed, the account, which tells how that magnificent old lady, her mind clear and vigorous to the end despite her emaciated and bed-ridden body, called her descendants together on the eve of her departure to distribute her earthly belongings among them, is a remarkable story of simple impressiveness and singular beauty. All the other chapters in the book are stories also beautifully told—the children playing with their dolls, the pilgrimage to Chimayo, the self-flagellation of the Penitentes, school days in Santa Fé, María's marriage to Julián, the birth of their first child and its subsequent death of fever, Julián's accidental discovery of the secret of making matte black pottery, the intrusion of the liquor traffic into the pueblo despite the efforts of the Indians themselves to suppress it, and Julián's death from over-indulgence in alcohol—these are vivid word pictures of life in the pueblo viejo.

Today the Pueblo of San Ildefonso is bypassed by a modern highway that leads from the City of the Holy Faith to the City of Destruction. María can hear the detonations of atomic energy, but, like her own residence which turns its back upon the highway, she ignores them and continues to make her pottery, which tells the story of a culture already ancient when Marcos de Niza searched for the Seven Cities of Cibola, of a culture whose history extends backward through forgotten centuries when generation after generation of Indians were begotten and gathered to their fathers, of Indians whose brief life span was spent in fighting off nomadic marauders, cultivating corn, constructing irrigation canals, and praying for rain. Perhaps, when the Gringos at Los Alamos have blown themselves to oblivion with their atomic bombs, there will still be Indians at San Ildefonso, tending their fires of sheep dung, and making matte black pottery. "Arise, and go down into the house of the potter, and there will I cause thee to hear my words."

THE NUBA. *An Anthropological Study of the Hill Tribes in Kordofan.*

By S. F. Nadel, with a foreword by Hubert Huddleston. Oxford University Press, London, New York, and Toronto. $11.00. xiv + 527 pp. + 25 plates + 1 map; text ill. 1947.

Although this anthropological study of the hill tribes of Kordofan, a part of the Anglo-Egyptian Sudan, was planned to be primarily of practical value to administrators and others interested in the particular geographical area concerned, it constitutes an interesting account of life in an area which has hitherto escaped thorough investigation by the rest of the world. Until 1926 the primitive pagan tribes inhabiting the Nuba hills were still held in check by military patrols; consequently, little was known of their customs, beliefs, or mode of life. The present volume, representing an intensive three-year study, is admirable in its detail and scope. It discusses the economic and social life of all the chief tribes. Among the topics touched upon are: agricultural techniques, tribal codes, chieftainship, hunting, political systems, adolescence, marriage, settlement and homestead, wealth, properties, industries, and Arab influence. The illustrations, though only fair from a photographic point of view, are very good as to subject. They show the nature of the country, the characteristics of the inhabitants, their dwellings, and their industries. While a student interested in this particular subject would not hesitate to procure this volume, the price may well dissuade more casually interested readers.

V. G. DETHIER

THE NEGRO FAMILY IN THE UNITED STATES. *Revised and Abridged Edition.*

By E. Franklin Frazier. The Dryden Press, New York. $3.75. xviii + 374 pp. 1948.

To reprint this classic on the negro family that first appeared in 1939, now brought up to date and given a form that makes it accessible to a larger public (through the elimination of appendices, statistical tables, and comprehensive bibliography), is a service of real merit. In a masterful way Frazier has described and analysed the present-day forms of the negro family: the rural and city "matriarchal" type, the old and new patriarchal types, and the different forms of decomposition families, as they have developed out of the subhuman situation of slavery, the shock of "liberation," the feudalism of the rural South, and the disorganizing and organizing influences of the Northern Big City. The solid factual foundation and objective scientific attitude of the book do not exclude the author's deep psychological understanding and human sympathy with the objects of the study. In many ways these developments of the negro family parallel the development of immigrant groups. That a sensitive white will often have to blush for his own group in reading this useful book is not the author's fault.

ERWIN H. ACKERKNECHT

ANTHROPOLOGIE DE LA POPULATION FRANÇAISE.

By Henri V. Vallois. Didier, Paris. 50 cents (paper). 132 pp. + 4 plates; text ill. 1943.

This is a very competent, though brief and semi-popular account of what has become known regarding the physical-anthropologic conditions prevailing in France. Henri Vallois, the foremost anthropological authority in France, frankly admits, and even emphasizes, that so far one can merely sketch a tentative outline of the historical and regional, racial composition of the French population, which differs only quantitatively, not qualitatively, from the peoples of the other nations of western Europe. Together with their interrelations, the usual, statistically adequate data on stature, length-width proportion of head and of nose, hair color, blood groups are briefly discussed, and very little else. In his analysis and guarded conclusions the author bravely adheres to the sound, old, and recently widely and violently attacked definition of race as "un groupe d'hommes présentant un ensemble de caractères physiques héréditaires communs. Les caractères de civilisation ou de langage n'on rien à faire avec la race."

The detailed, yet limited, conclusions in regard to French racial history and distribution contain nothing that is new in the literature. The booklet ends with this charge and appeal: ". . . nos données sur les races humaines de la France sont beaucoup moins étendues que celles que peuvent avoir les zoologistes ou les botanistes sur les races animales ou végétales de notre sol. Une telle ignorance devrait cesser."

A. H. SCHULTZ

POSTWAR GERMANS. *An Anthropologist's Account. By David Rodnick. Yale University Press, New Haven; Geoffrey Cumberlege, Oxford University Press, London.* $3.75. xii + 233 pp. 1948.

It is a pity that not all chapters of this book resemble chapters 12 to 15, which are honest and colorful reporting upon the opinions of three social-democratic militants, five members of the upper classes, and the party life of the Right and Left in the eastern part of Hesse in the American zone of occupation in Germany. The rest of the book unfortunately pretends to inform us about "the postwar Germans." The author bases his analysis on a five-month stay in a part of rural Hesse of a very particular character. During this time he interviewed 151 persons, had 278 questionnaires filled out by boys and girls from 12 to 19 years of age, obtained essays from 125 boys and girls between 10 and 20, and "observed" altogether 1500 Germans. The result of these profound studies are, as one would suspect, startling, or, to anybody who knows Germany, rather funny. We learn, for example, that "the mother more than the father is looked upon as the symbol of authority"; that "religion in Germany is largely fundamentalist," and "the churchgoing habit is strong in almost all classes"; that "German children, unlike many American children, have no hostile reactions to schools as such" and that "German children feel an obligation to 'love' their teachers"; that "the communist youth are the least anti-Allied in sentiment of any of the young people of Germany"; that "German villages are picturesque when viewed from afar, but the half-timbered dwellings are crowded together flush to the street with no lawns, and the small courtyards are filled with barns, sheds, pig pens, and manure piles." A particularly good joke is Rodnick's singlehanded "Kinsey" report on the sex life of young Germans.

In view of these "solid foundations" of Rodnick's book, one hesitates to follow him even when one feels he has hit upon something, as in his analyses of class structure, postwar changes in women's mentality, or political attitudes of the "lost generation." Once again the only thing that possesses lasting value is the body of original quotations from the youths' essays.

It is characteristic that many passages of this book on "Germans" are almost identical with a number in such books as those of Gorer and Mead on "Americans," which I have previously reviewed in this journal. The only explanation seems to be that these authors, somehow indoctrinated by psychoanalytic theory, project the same figments of imagination into their subjects; and that in addition they all seem in varying degrees unable to differentiate between specific national and specific class ideologies, although the latter are similar throughout different nations, or to differentiate either from general human attitudes. This new "social science" of "national characters" is about as scientific as the attempt to split atoms with a junior chemistry set.

ERWIN H. ACKERKNECHT

SOCIETAL EVOLUTION. *A Study of the Evolutionary Basis of the Science of Society. Revised Edition. By Albert Galloway Keller. Yale University Press, New Haven; Geoffrey Cumberlege, Oxford University Press, London.* $3.75. x + 419 pp. 1947.

Seventeen years after the second edition was first printed, and 33 years after its original publication, this book is reprinted as a sociological classic under the auspices of the William Graham Sumner Club. The author's thesis is that the Darwinian scheme may be applied to human society with more than the force of an analogy. In a real sense, he avers, variation, selection and counterselection, transmission, and adaptation occur on the social level. Students of evolution, if unacquainted with Keller, should remedy this deficiency. *Societal Evolution* is an interesting supplement to the symposium on *Levels of Integration in Biological and Social Systems.*

BENTLEY GLASS

INTELLIGENCE AND FERTILITY: *The Effect of the Differential Birthrate on Inborn Mental Characteristics. Occasional Papers on Eugenics, Number Two.*

By Cyril Burt. The Eugenics Society and Hamish Hamilton Medical Books, London. 2s. (paper). 43 pp. [1946] 1947.

The major question in eugenics is perhaps the question whether the level of intelligence in our present populations is, or is not, sinking because of lowered fertility in the higher income groups. For some thirty-five years the eminent author of this booklet has worked to secure a valid answer to the question, at least for the population of Great Britain. This slender paper-covered pamphlet, so inexpensive in terms of money, so priceless in terms of labor spent and knowledge gained, is his summary of what he and others have learned. Not least valuable is the appraisal, in an Appendix, of the meaning of intelligence.

The conclusions are these: (1) In Britain, there is a small but significant negative correlation, of about −0.20, between intelligence and size of family. (2) This negative correlation is enough to bring about a drop of 1.5–2.0 I. Q. points in the general level of intelligence in the population per generation. (3) The drop is faster in rural than in urban districts. (4) The reduction in intelligence is more important at the extremes of the frequency distribution than in the middle. For example, the decline is reducing the proportion of children of "scholarship grade" (I. Q. > 130) by one-half in little over 50 years, and in the same term is almost doubling the number of feebleminded (I. Q. < 70). This situation, which is probably equally grave in the United States, calls for a maximum effort to preserve our human resources.

There are, to be sure, many sources of error in the measures and calculations which lead to these conclusions. One bias, which can never be overcome, is produced by the general alteration in the social environment, which takes place from day to day. The reader of Sir Cyril Burt's dispassionate survey will, however, come unavoidably to a recognition that every possible precaution to reach a valid and reliable answer has been taken, and that the sources of error have been fully acknowledged and critically appraised.

The pamphlet, of course, only reveals the existence of a crucial problem. No solutions are suggested—that is work for the future, for the present and oncoming generations of students of human heredity and social relations to undertake.

BENTLEY GLASS

POPULATION ANALYSIS. *McGraw-Hill Publications in Sociology.*

By T. Lynn Smith. McGraw-Hill Book Company, New York, Toronto, and London. $4.50. xiv + 421 pp. + 1 map; text ill. 1948.

There is a great need for an up-to-date and comprehensive textbook of population analysis. One might have hoped that Smith's book would satisfy this need, but unfortunately such is not the case. In the first place the book is not up to date. Indeed, the greater part of the volume could have been—and perhaps was—written during the later years of the War. The more recent publications of the Census Bureau (including parts of the 1940 census) have not been used, nor has the author mentioned important projects in the field of population research which have been going on for several years. The presentation of world-wide data is largely limited to the reproduction of several tables from the *Statistical Yearbook* of the League of Nations, in some instances carried out so mechanically that countries still appear in the order of alphabetic listing in French, like the original publication.

Population Analysis is planned along conventional lines. In 21 chapters the author discusses the size and distribution of population, its composition, the vital processes, migration, and population growth. The handling of the Material, however, is very uneven. In some chapters a wealth of detail is presented, whereas other subjects are treated very briefly. Although Smith stresses the importance of acquainting the student with methodology, no reference to such widely used concepts as indirect standardization, the gross reproduction rate, the intrinsic rate of growth, the nuptiality table, and the logistic curve can be found. Census tracts, sampling procedures, the net reproduction rate, and population projections are mentioned but not discussed adequately. In addition to these omissions several positive errors have been made. The most serious of these appears in a rather elaborate chapter on immigration to the United States, where the discussion leaves the reader under the impression that the annual quotas still amount to two per cent of the foreign-born enumerated in 1890. Actually, from 1929 on, the quotas have been based upon the (estimated) national origin of the total white population in 1920. The book is well printed and illustrated with a profusion of charts and maps.

CHRISTOPHER TIETZE

BIOMETRY

INTRODUCTION TO MATHEMATICAL STATISTICS. *Wiley Mathematical Statistics Series.*

By Paul G. Hoel. John Wiley & Sons, New York; Chapman & Hall, London. $3.50. x + 258 pp. 1947.

In recent years a large number of introductory statistical textbooks has appeared. Nearly all of them have been directed toward students in specific fields of application, such as biology, economics, psychology, and so forth, and have oriented the presentation to the use of the methods rather than to their mathematical bases. On the other hand, there has been a real scarcity of introductory textbooks dealing with the mathematics of statistical methods. Hoel's book meets a very real need and meets it exceedingly well.

The book forms an excellent companion to a competent subject-matter textbook such as, for example, Hill's *Principles of Medical Statistics*. It assumes a knowledge of elementary calculus, but theory requiring more advanced training than that for its derivation is presented without proof. The biologist with a limited amount of mathematics at his command will not find this a formidable book, and will be helped by the liberal use of illustrative examples from biological and other fields. The fact that the book developed out of Hoel's experience in presenting the subject to science majors, and that he wrote with an awareness of the needs of applied statisticians has made this a singularly successful presentation for the scientist.

The author of any such treatise is faced with a very difficult problem in the selection of material. Here again one is impressed with the skill shown in planning the book. A good balance between classical large sample theory and small sample theory has been achieved. Recent developments in such topics as sequential analysis, discriminant functions, non-parametric methods, and the testing of hypotheses are introduced. References to more extensive treatments of these subjects are given, and a brief comment on what the reader may expect to find in these references is frequently included. Exercises at the end of each chapter add to the appeal of the book, both for undergraduate teachers and for the many scientists who try to get an understanding of statistical theory through their own study. For such students, it should be recognized that this book is not a substitute for a subject-matter textbook that gives thorough consideration to the problems inherent in the collection of data, the types of errors likely to be encountered, and interpretations relevant to a particular field. Thus scant attention has been given to the labeling of axes in terms of the data presented, or in attaching units to arithmetic results; and only superficial interpretations are attempted. The arithmetic examples serve their purpose, however, in making the mathematics more easily read and understood. The book can be heartily recommended to the growing group of biologists who are thinking in quantitative terms.

MARGARET MERRELL

FUNDAMENTALS OF STATISTICS.

By Truman Lee Kelley. Harvard University Press, Cambridge; Geoffrey Cumberlege, Oxford University Press, London. $10.00. xvi + 755 pp.; ill. 1947.

According to the author's preface, "An alternative title for this book which would emphasize the point of view is *Statistics, Its Philosophy and Method*. . . . The endeavor herein has been to place a great emphasis upon the logic and principles underlying the statistical study of phenomena, to provide, in the early chapters, such basic issues as will integrate thoughtful and investigative moods with statistical processes, and, in the later chapters, to give such treatment of modern processes as is required in handling many experimental situations and as will open to the reader the wealth of thought in current statistical literature. The early chapters constitute an elementary text. . . ."

As an elementary text, this will very likely be difficult for most students. The author's style of writing, a sample of which appears above, is often long and involved. One can also find occasional "orphan" sentences which appear completely out of context, as though the author had jotted down a random thought from time to time. There are, furthermore, many errors in the equations and text. These are, to be sure, minor errors for the most part, but they will greatly handicap the student. Finally, although the author claims to have emphasized the logic and principle underlying statistical procedures, he very often presents statistical concepts with no more explanation than one gets from the most dogmatic writers in this field.

Even the advanced student of statistics or the experimentalist will find this a spotty text. It treats some statistics—biserial r, point biserial r, and moments, for example—much more comprehensively than do most other texts. The reviewer, in fact, had certain long-standing queries cleared up here for the first time. Especially noteworthy is the final chapter, which deals with matrices, determinants, hypergeometric series, factorials, and other mathematical functions valuable in advanced statistical work. But then other equally important statistical techniques—curve fitting to experimental data and the analysis of variance—are completely ignored.

On the whole, this should be most valuable as a supplementary textbook because, despite its gaps, it contains many important, special formulae which are difficult to find elsewhere and because it treats many statistical techniques more intensively than probably any other comparable text. The examples and illustrations, incidentally, are well adapted for workers in the biological sciences.

A. CHAPANIS

GRUNDBEGRIFFE DER WAHRSCHEINLICHKEITSRECHNUNG. *Ergebnisse der Mathematik und ihrer Grenzgebiete. Volume Two.*

By A. Kolmogoroff. Chelsea Publishing Company, New York. $2.25 (paper). vi + 62 pp. 1946.

This is a reprint of a book written in 1933. It presents a certain probability theory as a mathematical discipline. Thus the subject proceeds from carefully stated axioms and definitions to the theorems that follow from them. The book is directed to students of probability and other mathematicians and cannot be read easily by others. For the biologist, it may be a satisfaction to know that such a book exists, since this type of mathe-

matical output has been productive of theory which the biologist has in the past found useful.

MARGARET MERRELL

THE THEORY OF MATRICES. *Ergebnisse der Mathematik und ihrer Grenzgebiete: Herausgegeben von der Schriftleitung des "Zentralblatt für Mathematik," Zweiter Band. Corrected Reprint of First Edition.*

By C. C. MacDuffee. Chelsea Publishing Company, New York. $2.50. vi + 110 pp. 1946.

This is a valuable survey of matrix theory, written for the pure mathematician. It is assumed, for example, that the reader knows what is meant by field, ring, abelian group, and divisor of zero (to take instances from the first three pages). The practising biometrician will find it heavy going.

C. P. WINSOR

CALCULUS OF FINITE DIFFERENCES. *Second Edition. By Charles Jordan; introduction by Harry C. Carver. Chelsea Publishing Company, New York.* $5.50. xxii + 652 pp. 1947.

This is a second edition of a textbook which Carver, in his Introduction, says "is destined to remain the classic treatment for many years to come." The text is sufficiently detailed to make little demand on the reader's mathematical education. The author has borne in mind the practical needs of the computer. His remarks on the construction and use of tables (§132 ff.) should be better known.

CHARLES P. WINSOR

DE OMNIBUS REBUS ET QUIBUSDAM ALIIS

SCIENCE NEWS 7.

Penguin Books, Harmondsworth, Middlesex. 1s. 6d. (paper). 128 pp. + 16 plates. 1948.

Among the eight articles in this issue of *Science News* there are two upon biological topics: Hearing of Insects (Gabriele Rabel); Anti-Vitamins (John Yudkin). There are also brief discussions (Research Notes) on the heart in starvation, the relation of climate to food, control of the tsetse fly, investigations of midges, and the use of radio-tracers in the study of embryonic processes and nutrition.

These booklets continue to maintain their high original standard of simple writing combined with authoritative exposition. It is a great misfortune that they are so hard to secure here in the United States.

NEWTON TERCENTENARY CELEBRATIONS, *15–19 July 1946.*

The Royal Society. Cambridge, at the University Press. $3.00. xvi + 92 pp. + 6 plates; text ill. 1947.

This handsome volume collects the lectures and addresses to the 119 delegates of 35 nations, given at the Newton Tercentenary Celebration, held under the auspices of the Royal Society at Cambridge. These include: Newton (E. U. da C. Andrade); Newton, the Man (Lord Keynes); Newton and the Infinitesimal Calculus (J. Hadamard); Newton and the Atomic Theory (S. I. Vavilov); Newton's Principles and Modern Atomic Mechanics (N. Bohr); Newton: the Algebraist and Geometer (H. W. Turnbull); Newton's Contributions to Observational Astronomy (W. Adams); Newton and Fluid Mechanics (J. C. Hunsaker). Three portraits of Newton and pictures of his rooms at Trinity College, his home at Woolsthorpe Manor, and a reproduction of a letter from Newton to Halley embellish the book.

CHYMIA. *Annual Studies in the History of Chemistry. Edgar F. Smith Memorial Collection: University of Pennsylvania. Volume I.*

Edited by Tenney L. Davis. University of Pennsylvania Press, Philadelphia; Geoffrey Cumberlege, Oxford University Press, London. $3.50. xiv + 190 pp. + 16 plates; text ill. 1948.

So handsome a book of essays in the history of chemistry as the one at hand will, it is to be hoped, encourage biologists to prepare the like. While the particular essays included in this first volume of a new series deal with subjects of rather indirect interest to biologists, they form a fitting memorial to C. A. Browne, whose last paper, one on the chemist Frederick Accum, stands at the beginning of the contents. The Edgar F. Smith Memorial Collection of the University of Pennsylvania deserves congratulations on so worthy an undertaking and so excellent a beginning.

THE AMERICAN COLLEGE DICTIONARY. *Text Edition. Edited by Clarence L. Barnhart, with the assistance of 355 authorities and specialists. Harper and Brothers, New York.* $5.00 ($6.00 with thumb index). xl + 1432 pp.; ill. 1948.

This is "the first general desk dictionary to be prepared by a staff of experts as large as that usually assembled for an unabridged dictionary." The basic list of words was provided by Lorge and Thorndike's *Teacher's Word Book of 30,000 Words.* This was supplemented by the specialists in various fields and by the use of glossaries

and special lists of several sorts. There is a single alphabetical listing of all entries, including proper names. The various meanings of a word are arranged in order of common usage. There are prefaces on Selection of Entries and Definitions (Irving Lorge); Pronunciation (W. Cabell Greet); Treatment of Etymologies (Kemp Malone); Synonyms and Antonyms (Miles L. Hanley); Usage Levels and Dialect Distribution (Chas. C. Fries); British and American Usage (Allen W. Read). Also included are A Handbook of Punctuation and Mechanics, A Guide to Letter Writing, Manuscript and Proof, Proofreader's Marks, Signs and Symbols, Table of Common English Spellings, Colleges and Universities in the United States, etc.

The authorities include 19 botanists and 48 zoologists and physiologists, all of whose names are well-known. Common terms in the biological sciences are all covered, and even a good many more technical terms, such as amphidiploid, rhizocarpous, and macrurous. New terms of importance, such as plutonium, Rh factor, and streptomycin, are present. There are some lapses in the definition of scientific terms, e.g., "*gene*, the unit of inheritance . . . which develops into a hereditary character as it reacts with the environment and with the other genes"; "*osmosis*, the tendency of a fluid to pass through a semipermeable membrane into a solution whose concentration is lower (sic) . . ." But on the whole, a high degree of accuracy is maintained. The dictionary is more than satisfactory as a desk guide.

BENTLEY GLASS

NEW READINGS IN MEDICAL GERMAN.

By Oscar C. Burkhard and Lynwood G. Downs. Henry Holt and Company, New York. $3.25. xiii + 200 pp. + cxiii; ill. 1947.

This is the sort of book for which there is a great need. Medical students struggling to acquire an adequate reading knowledge of the German language in order to be able to read the medical literature in that tongue with some degree of ease will find here most of what they need, namely: an introductory section dealing with common difficulties; a list of 100 common anatomical terms; a list of frequent abbreviations; figures of body structure and parts labelled in German; a 24-page selection from Lorenzen's *Der menschliche Körper;* 4 pages, from Beltz' *Sachkunde*, on bacteria; 62 pages from *Die Krankheit, ihre Entstehung und Behandlung*, by Bock; 18 selections from medical journals and encyclopedias on a variety of medical topics; several short reviews and abstracts. Difficult idioms are translated in footnotes. An ample vocabulary list completes the book.

For graduate students in the biological sciences in general, this treatment leaves something to be desired. The selections are too exclusively concerned with medicine, in particular with human anatomy and pathology. There is a corresponding restriction of vocabulary that omits general biological terms, especially in genetics, embryology, and evolution. The vocabularies of physiology, chemistry, and physics are likewise slighted. There is still a need for a book like this one in character, but directed to the biologist rather than the medical student. Until such a book is available, its place may be filled to a fair degree by the one under discussion.

BENTLEY GLASS

THE MICROSCOPE: *Its Theory and Applications. By J. H. Wredden, with an Historical Introduction by W. E. Watson-Baker. Grune & Stratton, New York.* $5.50. xxiv + 296 pp. + 23 plates; text ill. 1948.

The author states in his preface that he has written this volume to provide a source of critical information about microscopy, for industrial laboratories in particular. Two chapters are devoted to optical principles, six to a comprehensive discussion of the parts of the microscope, one to its use, and these are followed by a chapter each on the polarizing microscope, micrometry, photomicrography, and the preparation of specimens for examination. In addition, a most useful appendix provides tables of refractive indices, conversion tables, logarithms and anti-logarithms, and natural sines. The subject matter is handled well and simply, numerous illustrations are provided, and several new innovations in technique and application are included, making this a desirable volume for both laboratory and class reference. It is to be regretted, from the biologist's point of view, that no information on the phase and electron microscopes is provided; but it is probable that their inclusion would have created a problem of space, and the material would be of little value to the industrial worker.

C. P. SWANSON

THE CENTRAL NORTHEAST. *Look at America. By the Editors of Look in Collaboration with Gerald W. Johnson. Houghton Mifflin Company, Boston.* $5.00. 392 pp. + 1 map; text ill. 1948.

A fine pictorial survey of New York, New Jersey, Delaware, Pennsylvania, Maryland, West Virginia, and the District of Columbia. "Here," as Gerald Johnson puts it, "is the Main Entrance, the Front Office and behind it Plant Number One of the United States of America." This travel guide will convince any reader that it is also beautiful and full of historical interest.

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